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Aims and Scope

Annals of Geriatric Medicine and Research (Ann Geriatr Med Res, AGMR) is a peer-reviewed journal that aims to introduce new knowledge related to geriatric medicine and to provide a forum for the analysis of gerontology, broadly defined. As a leading journal of geriatrics and gerontology in Korea, one of the fastest aging countries, AGMR offers future perspectives on policymaking for older adults, clinical and biological science in aging researches especially for Asian emerging countries. Original manuscripts relating to any aspect of geriatrics, including clinical research, aging-related basic research, and policy research related to senior health and welfare will be considered for publication. Professionals from a wide range of geriatric specialties, multidisciplinary areas, and related disciplines are encouraged to submit manuscripts for publication.

General Information

The official journal title has been *Annals of Geriatric Medicine and Research* since September 2016 which followed the Journal of the Korean Geriatrics Society (1997-2016, pISSN: 1229-2397, eISSN: 2288-1239). It is the official journal of the Korean Geriatrics Society (http://www.geriatrics.or.kr/eng/) and the Korean Society for Gerontology (http://www.korea-biogerontology.co.kr). It is published in English quarterly on the last days of March, June, September, and December. The journal publishes original research articles, case reports, reviews, special contributions, and commentaries. Review board consists of members in 7 different countries. Articles are welcome for submission from all over the world. The contents of this Journal are indexed in Web of Science, Scopus, PubMed, PubMed Central (PMC), EBSCO, DOAJ, KoreaMed, KoMCI, KCI, DOI/Crossref, and Google Scholar. It is accessible without barrier from Korea Citation Index (https://www.kci.go.kr) or National Library of Korea (http://nl.go.kr) in the event a journal is no longer published.

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Challenges and Opportunities toward the Decade of Healthy Ageing in the Post-pandemic Era

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An 84-year-old woman with gait disturbance attributable to frailty and sarcopenia was admitted for rehabilitation. She exhibited functional improvement and continued outpatient rehabilitation in mid-February 2020. At that time, coronavirus disease 2019 (COVID-19) cases rapidly increased and strict social distancing was imposed country-wide. She could not visit our outpatient center for fear of infection and was lost to follow-up for over 3 months. Consequently, her mobility, which had been steadily improving, suddenly deteriorated. In general, older people are the most vulnerable victims of the COVID-19 pandemic, having not only virus-caused death and severe morbidity but also overall functional declines owing to their isolation and lack of care. In many countries, long-term care facilities are the epicenters of COVID-19 outbreaks. In such constant emergencies, it is nearly impossible to deliver interventions for geriatric conditions in clinical settings.[1] During the pandemic, "nonessential" community services were suspended, including senior activity and dementia daycare centers, geriatric day hospitals, and outreach rehabilitation programs.[2] Declines in physical activity and exercise have been reported in almost 50% of older adults living independently.[3] Soon, we expect to see studies on the extent of physical deterioration in older adults during the pandemic. The year-long failure of treatment for older patients who require timely care will also soon negatively impact population health indicators.

The United Nations declared 2020–2030 as the Decade of Healthy Ageing; associated activities aimed at ensuring health at all ages and involving a range of co-operating professionals are required to meet this goal.[4] A decade of concerted global action is urgently needed to ensure that older adults enjoy dignity, equality, and a healthy environment. However, one year into this project, the pandemic has overshadowed the healthy aging agenda. Indeed, the pandemic has highlighted the yawning gaps in policies, systems, and services. While some countries will emerge from the pandemic late in 2021, other countries will not.

How can we overcome the crisis in healthy aging during the pandemic? The need to insulate older adults from COVID-19 and optimize their overall health must be balanced. The Asian Working Group for Sarcopenia has made relevant recommendations.[2] The American Geriatric Society Healthy Aging Special Interest Group has also provided guidance to geriatric healthcare professionals; the suggested strategies would enhance healthy aging even in the era of COVID-19.[5] Despite the World Health Organization's concerns about the effects of the pandemic on the health of older people, we must renew the Decade of Healthy Ageing project.[6] The pandemic will continue to present serious challenges worldwide for many years. However, the crisis has forced governments, businesses, and societies to change rapidly, and some of these changes are positive. Many participants noted that the pandemic afforded an opportunity to re-set the current long-term care model, thus rendering it more person centered, with a focus on healthy aging. Furthermore, we have a unique opportunity to advocate for policies that invest in a long-term care model that views older people as vital contributors to healthy communities rather than simply the cost that society must bear. The provision of person-centered, non-discriminatory, accessible, integrated primary health and social care should be increased. Communities should be supported in terms of developing or maintaining the capacities of older people, both during the pandemic and beyond. Scale up of integrated care for older people will also require investment in and reinforcement of health systems.[7]

Alternative models of care are urgently needed during the pandemic. Telephone or video visits are also valuable. An information and communication technology-based integrated service model has been developed to provide effective management, enable consultation with distant professionals, and share medical information between acute care hospitals and long-term care institutions.[8] The

Korean Ministry of Health and Welfare temporarily allowed telephone-based consultation and prescription at the beginning of the COVID-19 outbreak. Community- or home-based medical care, including patient education, discharge care planning, and home-based monitoring, has also become crucial.[9] Essential medical care should continue during strict social distancing and when older adults cannot visit healthcare facilities. Telemedicine and telerehabilitation are developing rapidly as alternative models of care.[2] Geriatric care professionals assist patients and families to optimize health by referring them to digital resources whenever possible. While such resources were available before the pandemic, almost all have been extensively improved because it has become essential to interact in a virtual world.[5] More personalized and inclusive services will more effectively meet the needs of older adults, reduce the demand for hospital beds, and lower the risks of morbidity and mortality. Thus, clinical evidence and healthcare systems supporting such types of services should be developed via well-designed high-quality studies.

Annals of Geriatric Medicine and Research welcomes innovative research results of the professional geriatric community on healthy aging in the post-pandemic era, which will stimulate informative discussions. Future studies should continue to explore unprecedented challenges imposed by the pandemic and develop new interventions against another global pandemic impacting the health and social functioning of older adults. As we have entered the Decade of Healthy Ageing, governments, businesses, and community organizations worldwide must rise to the challenge. Everyone should be able to enjoy healthier, happier, and longer lives.

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CONFLICT OF INTEREST

The author claims no conflicts of interest.

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Geriatrics Fact Sheet in Korea 2021

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South Korea became an aged society in 2017 and is predicted to become a super-aged society by 2025. Therefore, knowing the trends among older adults and identifying the geriatric burden are crucial for both healthcare professionals and policymakers. We previously summarized the general health and socioeconomic profiles of Korean older adults from the 2017 National Survey of Living Conditions and Welfare Needs of Older Koreans. In this update, we briefly summarized the results of the 2020 National Survey of Living Conditions and Welfare Needs of Older Koreans by categorizing them according to their general aging profile, socioeconomic status, lifestyle, and health status. In addition, we reviewed recent updates in the field of frailty and sarcopenia from population-based community cohorts in Korea. We hope this study will serve as a current reference for nationwide statistical data on common clinical and social parameters used in geriatrics and gerontology.

Key Words: Aged, Frail elderly, Health services for the aged, Residence characteristics

INTRODUCTION

While the global population is aging, South Korea is one of the most rapidly aging societies worldwide. It took 17 years for Korea to transition to an aged society from an aging society, defined as proportions of the population aged 65 years or older of ≥ 14.0% and 7.0%, respectively, while Japan took 24 years for the same transition.[1] More strikingly, Korea is expected to become a super-aged society, defined as a proportion of the population aged 65 years or older of ≥ 20.0%, in 2025. This prominent trend of population aging in Korea has been, to some degree, attributed to rapid economic development that accompanies the fast-growing life expectancy at birth with the establishment of modern healthcare systems after the Korean War (1950–1953) and the lowest birth rate among developed countries.[2,3]

Many potential social and economic challenges arise from the unprecedented speed of population aging in Korea. Human aging biology leads to an increased prevalence of multiple chronic conditions, frailty, and functional decline in older adults.[4,5] Therefore, a given society must prepare to serve its aging population in a multifaceted manner, from developing fiscal policies to establishing healthcare models that are specially designed for older multimorbid individuals.[6] While many policies have been developed to tackle the aging population, the sustainability and viability of modern welfare systems and government-operated healthcare systems that were originally proposed in Western countries have not been

tested at this extreme pace of aging in Korea.

To establish future care policies for the older population, it is necessary to understand the dynamically changing social characteristics and health status of these people. In 2019, we summarized the general health and socioeconomic profiles of Korean older adults based on an analysis of data from the 2017 National Survey of Living Conditions and Welfare Needs of Older Koreans.[7] The present brief review updated the previous study from the preliminary results of the latest National Survey of Living Conditions and Welfare Needs of Older Koreans performed in 2020 by the Ministry of Health and Welfare, Republic of Korea.[8] This survey was conducted for 9 months, from March 2020 to November 2020, and encompassed 969 nationwide investigation districts and 10,097 older adults aged over 65 years. The survey investigated the general information, family and social relationships, health and functional status, economic status, leisure and social activity, and living environment of this population. For disabilities, we used data from the 2019 Long-Term Care Status Survey, a triennial study started in 2019 to assess the population characteristics of long-term care insurance (LTCI) and related services.[9] In addition, we provided a brief updated summary of recent literature from population-based studies on age-related conditions in Korea.[10] Based on this study, we intended to provide an up-to-date reference for Korean nationwide statistical data on common clinical and social parameters used in research on geriatrics and gerontology.

PROFILE OF AGING IN KOREA

According to the Korean statistics in 2019, the population aged 65 years or older was 7,746 thousand persons, accounting for 15.5% of the total population, a 4.8% increase compared to the previous year.[11] The overall life expectancy at birth was 86.3 years in women and 80.0 years in men. In particular, the remaining life expectancies at 60 years of age were 28.1 and 23.3 years for women and men, respectively, which were an increase of 0.6 and 0.5 years, respectively, from 2018.[12]

SOCIOECONOMIC STATUS OF KOREAN OLDER ADULTS

The private income of older adults per year has steadily increased to US$13,939 compared to US$10,384 (2017) and US$8,430 (2014). More than one-third (36.9%) of the total older adults and 55% of older adults aged 65–69 years were currently working. The proportion of employee/self-employment income and private pension increased significantly, which subsequently increased the chance of financial independence. Most older adults (78.2%) lived as a single household: living alone or living with a spouse with frequent (more than once weekly) contact with their children, friends, and neighbors. The level of education had also increased markedly; the uneducated group shrank to 10.6% (33% in 2008), while the proportion of older adults with education beyond high school increased to 34.3% (17.2% in 2008) (Table 1).[8]

LIFESTYLES OF OLDER KOREANS

The most important lifetime activities were hobbies and leisure (37.7%), followed by economic (25.4%), social (19.3%), religious (14.1%), volunteer (1.7%), and learning activity (0.9%). Smartphone users accounted for 56.4% of the population, and the ability to use smartphones was far superior in young-old adults. For instance, 92.4% of individuals aged 65–69 years could send text mes-

Table 1. Socioeconomic status of older Koreans

Index	Unit (%)	
	2017	2020
Annual private income (US dollar)	10,384	13,939
Type of income		
Employee income	13.3	24.1
Self-employment income	13.6	17.1
Property income	12.2	11.0
Private transfer	22.0	13.9
Public transfer	36.9	27.5
Private pension	0.8	6.3
Participation in economic activities		
Currently working	30.9	36.9
Previously worked	59.3	49.5
Never worked	9.8	13.6
Residence type		
Living alone	23.6	19.8
Living with spouse	48.4	58.4
Living with children	23.7	20.1
Other	4.4	1.7
Social network[a]		
Children (come-and-go)	38.0	16.9
Children (contact)	81.0	63.5
Friends or neighbors (contact)	64.2	71.0
Relatives (contact)	16.8	20.3
Level of education		
Uneducated (illiterate)	24.3	10.6
Elementary school (≤ 6 y)	34.1	31.7
Middle school (> 6 and ≤ 9 y)	16.9	23.3
High school (> 9 and ≤ 12 y)	17.3	28.4
Beyond college (> 12 y)	7.5	5.9

[a]More than once a week.

sages compared to 19.9% among those aged 85 years and older. Most (83.8%) older Korean adults preferred to live in the same place, and more than half (56.5%) of the adults also desired aging-in-place even with an impaired mobility status. The level of overall satisfaction with life was 49.6%. Satisfaction with health status increased considerably from 37.1% (2017) to 50.5% (2020). The satisfaction with economic status also increased from 28.8% (2017) to 37.4% (2020) (Table 2).[8] However, these trends should be interpreted with some caution with possible cohort or period effects along with drastic social changes.

GERIATRIC SYNDROMES AND COMMON COMORBIDITIES

Common Medical Conditions

The average number of chronic diseases in Korean older adults was 1.9, with 84% of the population having more than one chronic disease. In comparison, 89.5% of the older population had one or more chronic diseases, 73% had two or more, and 51% had three or more in 2017. The top five chronic diseases were hypertension (56.8%–64.4%), diabetes mellitus (24.2%–29.0%), dyslipidemia (17.1%–38.9%), osteoarthritis (16.5%), and lumbar pain or sciatica (10%). Notably, the rate of depressive symptoms steadily decreased to 13.5% compared to 30.8% in 2008 and 21.1% in 2017 (Table 3).[8,13-15]

Among the recipients of LTCI, the mean number of chronic diseases was 3.4 according to the 2019 Long-Term Care Status Survey.[9] In this population, the common diseases included hypertension (60.3%), dementia (57.2%), diabetes (29.3%), arthritis (27.8%), and stroke (25.8%). LTCI recipients took a mean of 9.8 daily medications, and 79.4% of them took five or more medications per day.

Functional and Cognitive Status

Functional disability was assessed based on activities of daily living

Table 2. Lifestyle of older Koreans

Index	Unit (%)	
	2017	2020
Most important activity in current life	NA	-
Hobby and leisure activity	-	37.7
Economic activity	-	25.4
Social activity	-	19.3
Religious activity	-	14.1
Volunteer activity	-	1.7
Learning activity	-	0.9
Smartphone user	NA	56.4
Preferred residency (healthy state)		
Living in the same place	88.6	83.8
Moving to a better environment	11.4	16.1
Preferred residency (dysmobility state)		
Living in the same place	57.6	56.5
Living with spouse/children/siblings	10.3	7.2
Living close to children/siblings	-	4.9
Older adult care facility	31.9	31.3
Life satisfaction		
General	NA	49.6
Health status	37.1	50.5
Economic status	28.8	37.4
Health awareness		
Healthy	37.1	49.3
Neither healthy nor unhealthy	23.3	30.8
Unhealthy	39.7	19.9

NA, not applicable.

Table 3. Health status and common comorbidities of Korean older adults

Index	Unit (%)	Reference
Number of chronic diseases		8)
≥ 1	84	
≥ 2	54.9	
≥ 3	27.8	
Type of chronic disease (top 5)		
Hypertension	56.8–64.4	8,13,14)
60–69 y	51.5	
≥ 70 y	67.2	
Diabetes mellitus	24.2–29.0	8,13,15)
60–69 y	24.2	
≥ 70 y	31	
Dyslipidemia	17.1–38.9	8,13)
60–69 y	42.8	
≥ 70 y	35.1	
Osteoarthritis	16.5	8)
Lumbar pain and sciatica	10	8)
Cognitive decline	25.3	8)
Dementia	10.3	16)
65–69 y	4.2	
80–74 y	8.9	
75–79 y	22	
80–84 y	27	
≥ 85 y	35.2	
Depressive symptoms	13.5	8)
Male	10.9	
Female	15.5	
Functional status		8)
IADL disability	6.6	
ADL+IADL disability	5.6	

ADL, activities of daily living; IADL, instrumental activities of daily living.

(ADL) and instrumental activities of daily living (IADL). Approximately 6.6% of older adults had limitations only in IADL, while 5.6% of older adults had limitations in both ADL and IADL. The prevalence of cognitive impairment increased to 25.3% compared to 14.5% in 2017. In addition, the prevalence of dementia was 10.33%, and increased with age (Table 3).[8,16]

Disabilities and Healthcare Needs

The proportion of LTCI recipients has been increasing in the total Korean population, from 1.0% in 2016 to 1.3% in 2018, according to the 2019 Long-Term Care Status Survey.[9] Among the recipients, 83.5% of the population used at least one long-term care service among home-based and institution-based services, at a ratio of 7:3. Regarding eligibility levels, 4.5%, 11.4%, 32.2%, 43.8%, and 7.7% of recipients were classified into levels 1, 2, 3, 4, and 5, respectively.[10]

Among all LTCI recipients, the mean number of clinic visits for the last quarter was 5.3, with 11.1% of recipients visiting clinics more than 10 times in the last quarter. In addition, 26.8% of the recipients had experienced hospitalization within the last 12 months, with 12.6% of the recipients experiencing institutionalization to convalescent hospitals.

Frailty Status

The prevalence of frailty in Korean older adults ranged from 2.5% to 55.7%, as defined by the Cardiovascular Health Study (CHS) frailty phenotype, frailty index, and other operational measures (Table 4).[17-30] Recent Korean studies have shown that either frailty index, phenotype model, or physical performance measures could similarly identify older individuals at risk for geriatric adverse outcomes.[18] In addition, gait speed was inversely related to the frailty index and predicted adverse health outcomes (mortality or institutionalization).[31] The Timed Up and Go test was associated with both the CHS frailty phenotype and total Short Physical Performance Battery.[20]

Sarcopenia

The prevalence of sarcopenia ranges from 4% to 46.8% according to different diagnostic criteria. Recent population-based studies have investigated diagnostic tools for sarcopenia (Table 5).[32-39]

Table 4. Prevalence of frailty in Korean older adults

Frailty assessment		Prevalence (%)	Settings	Regions		Publication year	Study
				Urban	Rural		
Frailty screening	CFS	51.0	Hospital (inpatients)	NA	NA	2021	Ko et al.[23]
		45.1	Hospital (inpatients)	NA	NA	2021	Han et al.[17]
	FRAIL questionnaire	27.0	Community		○	2016	Jung et al.[19]
		12.4	Community	○	○	2018	Kim et al.[22]
		31.2	Hospital (inpatients)	NA	NA	2021	Han et al.[17]
	KFI	21.3	Community	○		2010	Hwang et al.[30]
		9.1	Community	○	○	2018	Kim et al.[22]
	CSHA frailty definition	20.2	Community	○	○	2017	Ko et al.[24]
	TUG[a]	38.4	Community	○	○	2020	Lee et al.[25]
	SPPB[b]	18.2	Community	○	○	2020	Jung et al.[20]
		55.7	Community		○	2021	Jung et al.[18]
Frailty phenotype	SOF	2.5	Community	○	○	2018	Kim et al.[22]
	CHS phenotype	8.4	Community	○	○	2008	Park et al.[28]
		13.2	Community	○		2014	Jung et al.[21]
		17.0	Community		○	2016	Jung et al.[19]
		11.4	Community	○	○	2018	Kim et al.[22]
		7.7	Community	○	○	2020	Lee et al.[26]
Frailty index	KFI-PC	17.5	Community	○	○	2020	Won et al.[29]
	Frailty index	26.3	Community		○	2021	Jung et al.[18]
Social frailty	Social frailty index	20.5	Community		○	2019	Park et al.[27]
	Social deficit level	32.4	Community	○	○	2020	Lee et al.[26]

CFS, Clinical Frailty Scale; CHS, Cardiovascular Health Study; CSHA, Canadian Study of Health and Aging; KFI, Korean Frailty Index; KFI-PC, Korean Frailty Index for Primary Care; K-FRAIL, Korean version of the Fatigue, Resistance, Ambulation, Illness, and Loss of weight scale; SOF, Study of Osteoporotic Fracture; TUG, Timed Up and Go test; NA, not available.
[a]10 seconds or longer was regarded as frail. [b]9 seconds or less was regarded as frail.

Table 5. Prevalence of sarcopenia in Korean older adults

Criteria		Prevalence (%)	Data sources	Regions		Publication year	Study
				Urban	Rural		
Skeletal muscle (ASM/height^2 < 1 SD)	Total	5.2	Community	○	-	2010	Lim et al.[39]
	Male	6.3					
	Female	4.1					
Skeletal muscle (ASM/height^2 < 2 SD)	Total	4.0	Community	○	○	2015	Kim et al.[36]
	Male	9.3					
	Female	0.2					
Low handgrip strength (< 26 kg, male and < 18 kg, female)	Total	46.8	Community	○	○	2017	Oh et al.[32]
	Male	33.2					
	Female	57.4					
AWGS (2014)	Total	16.5	Community	-	○	2018	Jang et al.[35]
	Male	14.0					
	Female	18.5					
AWGS (2014)	Total	10.2	Community	○	○	2018	Kim et al.[38]
	Male	11.4					
	Female	9.1					
AWGS (2014)	Total	16.1	Community	○	-	2019	Cha et al.[33]
	Male	-					
	Female	-					
EWGSOP (2010)	Total	8.8	Community	○	-	2015	Kim et al.[36]
	Male	8.8					
	Female	8.8					
EWGSOP (2010)	Total	20.8	Community	○	○	2019	Kim et al.[37]
	Male	25.5					
	Female	16.2					
EWGSOP2 (2019)	Total	9.3	Community	○	○	2019	Kim et al.[37]
	Male	11.9					
	Female	6.7					
EWGSOP2 (2019)	Total	14.7	Community	○	○	2021	Hong et al.[34]
	Male	-					
	Female	-					

ASM, appendicular skeletal muscle; AWGS, Asian Working Group for sarcopenia; EWGSOP, European Working Group on Sarcopenia in Older People.

Calf circumference has been proposed as a surrogate marker of muscle mass because it was well correlated not only with appendicular muscle mass and skeletal muscle index but also with physical function.[40] In addition, skeletal muscle radiodensity measured using computed tomography at the third lumbar vertebra level was positively associated with jump power, which was positively correlated with sarcopenia, as defined by the European Working Group on Sarcopenia in Older People (EWGSOP2).[34] Recently, a novel sarcopenia phenotype score (SPS), which is the sum of each abnormal sarcopenic marker (low muscle mass, low handgrip strength, and slow gait speed), was proposed in the Aging Study of PyeongChang Rural Area cohort. The SPS showed better dose-response predictability of adverse health outcomes (mortality and institutionalization) compared to the pre-existing sarcopenia definition, especially the revised definition from the EWGSOP.[41]

CONCLUSION

Mostly living as a single household, Korean older adults had higher education levels and higher private income compared with that reported previously. In contrast to previous reports from the 2017 survey, we noted the increasing adoption of information technology in the older population. Moreover, economic status is improving in this population. We also observed trends in the older population of caring for their own health and having improved satisfaction with their general health. Healthcare providers and policymakers should reflect these current characteristics of older adults to pursue healthy aging and establish an age-friendly healthcare

environment.

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CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

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AUTHOR CONTRIBUTIONS

Conceptualization, JYB, IYJ; Data curation, JYB, HWJ, IYJ; Investigation, JYB, HWJ; Methodology, JYB, IYJ; Supervision, HWJ, EJL, IYJ; Writing-original draft, JYB, HWJ; Writing-review & editing, JYB, HWJ, EJL, IYJ.

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Post-intensive Care Syndrome

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The increasing survival rate after discharge from the intensive care unit (ICU) has revealed long-term impairments in the cognitive, psychiatric, and physical domains among survivors. However, clinicians often fail to recognize this post-ICU syndrome (PICS) and its debilitating effects on family members (PICS-F). This study describes two cases of PICS to illustrate the different impairments that may occur in ICU survivors. The PICS risk factors for each domain and the interactions among risk factors are also described. In terms of diagnostic evaluation, limited evidence-based or validated tools are available to assist with screening for PICS. Clinicians should be aware to monitor for its symptoms on the basis of cognitive, psychiatric, and physical domains. The Montreal Cognitive Assessment is recommended to screen for cognition, as it has a high sensitivity and can evaluate executive function. Mood disorders should also be screened. For mobile patients, a 6-minute walk test should be performed. PICS can be prevented by applying the ABCDEF bundle ABCDEF bundle in ICU described in this paper. Finally, the family members of patients in the ICU should be involved in patient care and a tactful communication approach is required to reduce the risk of PICS-F.

Key Words: Critical care, Neurocognitive disorders, Patient care bundles, Continuity of patient care, Physical and rehabilitation medicine

INTRODUCTION

Case 1

Mr. A, a 74-year-old man, presented to the emergency department (ED) with a fever and rigor 2 days after an ultrasound-guided transrectal prostate biopsy. He had a history of benign prostate hypertrophy, stage 2 chronic renal failure, hypertension, and hyperlipidemia and was an ex-smoker of 60 pack-years. He was hypotensive and had generalized tonic-clonic seizures at arrival. He was admitted to the intensive care unit (ICU) for septic shock and was treated with intravenous broad-spectrum antibiotics, inotropic support, and anti-epileptic drugs. His ICU admission was complicated by worsening type 1 respiratory failure due to hospital-acquired pneumonia (HAP). Recurrent failed extubation resulted in a tracheostomy 2 weeks later and 1 month after intubation, before he was successfully weaned off ventilatory support. He was transferred out of the ICU after 5 weeks to a medical ward fully dependent on nasogastric feeding. The geriatric medical team engaged allied health professionals for his care, including physiotherapy, occupational therapy, dietitian, and speech-language therapy. Despite fatigue initially limiting his participation in rehabilitation and complications from HAP and upper gastrointestinal bleeding, he gradually showed improvement under the individualized graded exercise program. On discharge after 4 months in hospital, the patient was able to mobilise with a zimmer frame. Within 1 year, tracheostomy decannulation was performed and the patient returned to normal oral feeding, and in 18 months, the patient fully recovered to independence in all activities of daily living (ADLs).

Three years later, the patient presented to the Geriatrics Clinic for auditory and visual hallucinations, insomnia, and nocturnal wandering. He self-reported cognitive decline, particularly short-term memory loss and word-finding difficulty. His family noted

increasing agitation and irritability, as well as increasing difficulties using a cellphone and performing prayers. He denied having depression or anxiety. His wife complained of increased stress because of his behavioral changes, in addition to sleep deprivation and disruption of her daily routine. His Montreal Cognitive Assessment (MoCA) score was 7/20, with memory deficits, delayed recall, language, abstraction, naming, visuospatial, and executive function. He was diagnosed as having moderate-to-severe dementia with behavioral and psychological symptoms of dementia and post-intensive care syndrome (PICS).

Case 2

Ms. T, a 70-year-old woman, presented to the ED with a 4-day history of fever and cough. She had a history of hypertension, hyperlipidemia, and uncomplicated type 2 diabetes mellitus. She was hypoxic and hypotensive despite initial fluid resuscitation and non-invasive ventilatory support. She was admitted to the ICU for severe community-acquired pneumonia, rapid atrial fibrillation, and multi-organ failure. She required short-term hemodialysis for renal support and prolonged intravenous antibiotics for ongoing bacteremia. She underwent a tracheostomy owing to her prolonged need for ventilatory support and nasogastric feeding. After 2 months in the ICU, she was transferred to a geriatric medicine ward and was fully dependent for all ADLs. Her rehabilitation was complicated by fatigue, anxiety, and labile glycemic control. She was discharged after 3 months of hospitalization and was able to transfer to a wheelchair with assistance.

Tracheostomy decannulation, normal oral diet, and return to independent mobility were achieved within 1 year. During the clinical follow-up, she reported having anxiety, with occasional flashbacks of her ICU admission. Three years later, she reported having short-term memory loss, which did not affect her ADLs. The patient was diagnosed as having mild cognitive impairment and PICS.

Background

Although survival rates in patients with critical illness and requiring ICU care are increasing, survivors may develop long-term impairments within one or more of the cognitive, psychiatric, and physical domains.[1] This cluster of impairments is known as PICS. This diagnosis excludes patients having traumatic brain injuries or stroke. Similar debilitating effects on family members, particularly psychological symptoms among those caring for the patient in the ICU and after discharge, are termed post-intensive care syndrome-family (PICS-F).

It is important to be aware of this condition in older patients. The number of older people with critical illnesses is increasing with an increase in the aging population. Compared with other patient populations, older patients account for more ICU admissions and have a high risk of delirium, which is a risk factor for developing cognitive dysfunction in PICS.[2,3]

Approximately 50%–70% of all ICU survivors have at least one PICS-related impairment, which can persist for up to 15 years after discharge.[4] A study of Medicare beneficiaries (mean age of 76.9 years) found that 60% of 1,520 ICU hospitalizations with severe sepsis were associated with worsening cognitive or physical functioning 1 year after hospitalization, with 16.7% of survivors showing moderate-to-severe cognitive impairment.[5,6] A retrospective cohort study of 21,520 Medicare patients revealed that ICU stays of 3 days or longer, sepsis severity, older age, frailty, depression, and dementia increased the odds of physical disability in older adults receiving home care.[7] Another study reported that 15% of older ICU survivors had a new diagnosis of dementia 3 years post-ICU stay, with almost 40% of new dementia cases diagnosed during the first year post-ICU stay.[8]

RISK FACTORS FOR PICS

The risk factors for PICS partly depend on which among the cognitive, psychiatric, and physical domains are most affected. These three components are interrelated, with impairment in one domain frequently being associated with worsening function in another. The risk factors for each domain are summarized in Fig. 1.

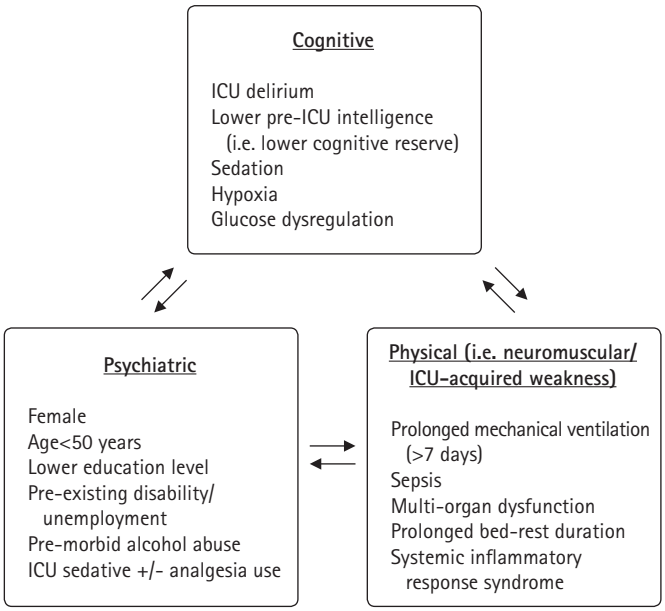

Fig. 1. The post-intensive care syndrome (PICS) risk factors for each domain. ICU, intensive care unit.

Cognitive PICS (Case 1)

The major risk factors for cognitive PICS include delirium, poor cognitive reserve, sepsis, and acute respiratory distress syndrome. The duration of delirium is reportedly an independent risk factor for cognitive impairment at 6 and 12 months.[9] However, there is no strong evidence suggesting that older adults are at a higher risk for cognitive PICS than are younger adults. A prospective study of 821 ICU patients showed similar cognitive and executive function scores between patients aged 65 years and older and younger patients at 3 and 12 months after discharge.[2] Patients with a higher level of education, an indicator of cognitive reserve, had a lower risk of this complication at 3 and 12 months.[10] Severe sepsis survivors were three times more likely to develop moderate-to-severe cognitive dysfunction. It is unclear whether cognitive dysfunction is due to acute respiratory distress syndrome itself, complications from sepsis, or the use of mechanical ventilation.

The main cognitive functions affected include attention or concentration, mental processing speed, memory, and executive function. The latter two are necessary for engaging in purposeful, goal-directed behaviors. Loss of these functions tends to impair rehabilitation participation, resulting in poor functional outcomes. Survivors have self-reported severe cognitive impairment after ICU discharge that has persisted for up to 2 years.[11]

Physical PICS (Cases 1 and 2)

Approximately 50% of older ICU survivors show functional recovery after critical illness, with a median recovery time of 3 months.[6] Older survivors of severe sepsis developed 1.5 new limitations in ADLs, compared with 0.5 in their non-ICU counterparts.[12] Older survivors who were mechanically ventilated were 30% more likely to have an ADL disability.[13] The physical impairments result in a need for increased support after hospital discharge.

Pre-existing functional disability, cognitive impairment, and frailty are strongly associated with physical PICS or ICU-acquired weakness (ICU-AW). Prolonged mechanical ventilation (>7 days), immobility, ongoing inflammatory response syndrome from sepsis, and multi-organ dysfunction are also associated with the development of ICU-AW. The pathophysiology of this condition is as follows: microvascular ischemia, catabolism, and prolonged immobility cause skeletal muscle wasting, whereas microvascular injury results in nerve ischemia, nerve-related sodium channel dysfunction, and mitochondrial injury. This leads to critical illness-related neuropathy, myopathy, or both.[14]

The BRAIN-ICU study found that physical disability significantly contributed to poor mental health and quality of life at 3 and 12 months post discharge.[15] However, the nature of this interaction among physical impairment, mental health, and quality of life in ICU survivors requires further evaluation.

Psychiatric PICS (Case 2)

Patients who develop critical illnesses have higher incidences of premorbid psychiatric illness than do patients who do not require ICU hospitalization and the general population.[16] Whereas ICU survivors have a 4- to 6-fold higher rate of psychiatric comorbidities than in the general population, those with psychiatric PICS tend to have underlying pre-existing psychiatric disorders. Depression, anxiety, and post-traumatic stress disorder (PTSD) are the three common manifestations of psychiatric PICS, occurring in 19%–37%, 32%–40%, and 19%–22% of patients, respectively.[6]

DIAGNOSTIC EVALUATION OF PICS

Diagnosing PICS is challenging because of the failure of early recognition and lack of screening tools for these patients. Serial assessments using history, physical examination, investigations (if required), and multidisciplinary consultations between specialists and therapists are essential to systematically evaluate the PICS domains.

There are no validated cognitive screening tools for PICS. While the MoCA, Mini-Mental State Examination, and Mini-Cog are widely used, they are poor predictors of cognitive impairment at 6 months or longer after discharge.[17] As executive dysfunction is the main cognitive domain affected in PICS, the Society of Critical Care Medicine (SCCM) recommends using the MoCA, as it has a component on executive function and is sensitive for detecting mild cognitive impairment.[18]

Clinicians should also screen for mood disorders, particularly anxiety, depression, and PTSD.[19] Again, there are no adequately validated questionnaires for survivors of critical illnesses. The commonly used tools include the Hospital Anxiety and Depression Scale (HADS), Impact of Events Scale-Revised (IES-R), and the six-item Impact of Event Scale-6 (IES-6). If a mood disorder is identified, patients should be asked about sexual health problems and sleep hygiene, as both issues tend to occur concurrently and may worsen psychiatric PICS.

The manifestations of physical PICS (ICU-AW) can range from generalized poor mobility and multiple falls to generalized muscular weakness. This can be due to disuse or deconditioning; however, definitive diagnoses should be sought for critical illness myopathy (CIM), critical illness polyneuropathy (CIP), and critical illness polyneuromyopathy (CIPNM). CIM tends to be more proximal than distal weakness with sensory preservation and atrophy depending on the illness duration, whereas CIP is more distal than proximal, with limited atrophy. CIPNM is a combination of proxi-

mal and distal weaknesses, with distal sensory loss and variable atrophy. For all three types, reflexes tend to be preserved initially but gradually disappear as the weakness progresses, sparing the bulbar musculature.[20]

It may be challenging to specify the diagnosis of physical PICS because of the overlap of the conditions and the limited clinical examination possible for sedated or intubated patients. For example, it may be difficult to differentiate between CIP in patients with pre-existing diabetic peripheral neuropathy before ICU admission. However, as with both patients described here, failure to wean off ventilatory support may be an early indicator of physical PICS, requiring confirmatory electrodiagnostic tests such as nerve conduction studies and electromyography.

One of the main tests used to measure changes in strength and functional outcomes in the ICU is the physical function outcome measure (PFIT). This tool was initially developed to measure endurance, strength, cardiovascular capacity, and functional level among mechanically ventilated tracheostomy patients who were able to stand, with the test repeated after weaning from ventilation.[21] The tests involved assessments of strength for shoulder flexion and knee extension, level of assistance required for sit-to-stand, and step cadence in steps per minute. The PFIT demonstrated high inter-rater reliability and sensitivity in ICU patients.[22]

In the ICU setting, the 6-minute walk test (6MWT) and Timed Up and Go (TUG) test may not be practical, as they require space and consideration of how to manage drips, drains, and oxygen delivery systems when the patient is walking or turning. However, a 6MWT should be performed in extubated and mobile ICU patients. A randomized controlled trial of patients admitted to the ICU for 5 days or longer comparing the results of the 6MWT, TUG, and PFIT at admission, discharge, and follow-up showed that the 6MWT was able to demonstrate the rate of change over time and between-group differences for the intervention group (intensive exercises in ICU, wards, and outpatients) and the control group (standard care).[23] Thus, for ICU patients, although the PFIT may be used for initial assessment, the 6MWT should be used for follow-up once the patient is extubated and able to start mobilizing.

It is important to obtain early input from physiotherapists and occupational therapists for assessment and management, including preemptive prevention of complications such as contractures, preferably while the patient is still in the ICU.[20,24]

Comprehensive geriatric assessment should be performed, with continual assessment and rehabilitation until discharge. Dietitian input for nutrition assessment and intervention is important to ensure that nutritional requirements are met during the recovery phase.

It is also crucial to identify the presence and severity of pre-existing illnesses within the three domains, as unchanged symptoms do not support the diagnosis of PICS. This is challenging for those without the cognitive capacity to compare their current status with symptoms before admission. Engagement with close family members is beneficial in identifying the presence and nature of pre-existing comorbidities. In addition to collateral history obtained from caregivers and family, pre-existing clinical records of diagnoses, investigations, cognitive tests, and functional assessments, such as from previous physiotherapy sessions (if available), are valuable in objectively confirming acute changes post-ICU stay compared with baseline. Unfortunately, the cognitive status before ICU admission, particularly objective measures, is usually unavailable. A systematic review also found that most publications on PICS lacked information on baseline cognitive status; thus, it was not possible to determine whether the observed cognitive deficits arose de novo or represented worsening of pre-existing cognitive deficits.[25]

MANAGEMENT OF PICS

The management of PICS is divided into two parts: within the ICU and post-ICU stay. Intensivists can reduce the risk of PICS by minimizing sedation, avoiding psychotropic use including antipsychotics and anticholinergic agents, avoiding hypoglycemia and hypoxemia, environmental modifications, and prioritizing early physical rehabilitation and mobility for older people. The ABCDEF bundle approach shown in Fig. 2 has been shown to reduce the likelihood of death within 7 days, mechanical ventilation, coma, delirium, and the use of physical restraints.[26,27]

Treatment of patients with PICS involves managing individual impairments in each domain through multidisciplinary care. The physician responsible should coordinate care with other clinicians and allied health professionals. Early physical therapy once a patient is stable from cardiorespiratory and neurological perspectives may decrease cognitive impairment, improve physical function, and reduce psychiatric comorbidity. Cognitive enhancers and cognitive rehabilitation through memory training are not effective in PICS. Thus, further studies are needed to identify evidence-based treatments for this condition.

Although there is limited evidence to guide the discontinuation of antipsychotics in the post-ICU phase, it is recommended to use the smallest dose possible for behavioral disturbance from postoperative delirium and to discontinue their administration as soon as possible.[16] If antipsychotics are required after discharge, the benefits versus risks should be considered for individual patients.

The optimal follow-up and natural progression of PICS remain

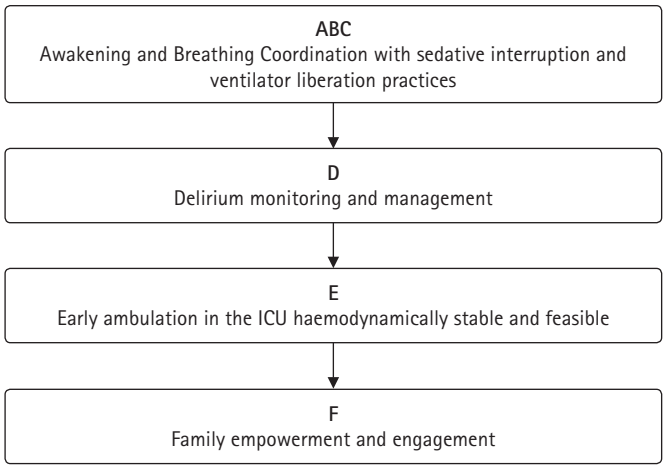

Fig. 2. The ABCDEF bundle approach. ICU, intensive care unit.

uncertain, but most patients are followed up for several years at regular intervals. We recommend follow-ups every 3 months after discharge, followed by individualized intervals according to the needs of each patient. This is important, as symptoms may become more apparent at a later stage, as seen in Case 1. The care of older people with PICS requires a multidisciplinary approach, including intervention by medical specialists, general practitioners, therapists, and social services. If available, referrals to established PICS peer support groups may assist in reducing psychological stress. Although PICS clinics have been introduced in the UK and the United States, evidence of their benefits remains conflicting.

The symptoms and signs of PICS improve modestly over the first 6 to 12 months after ICU discharge. However, most patients have deficits persisting for years, with an associated inability to work, a reduced quality of life, and an increased risk of mortality.[28] The effects of preventative or therapeutic interventions on these outcomes remain unknown, as is the risk for subsequent hospitalizations, critical illnesses, or PICS recurrence.

An important component of the ABCDEF bundle is family empowerment and engagement. Clinicians should evaluate family members for PICS-F, as they may also develop persistent physical and psychological symptoms after patient discharge. The risk factors for PICS-F are divided into those related to caregivers, patients, and the healthcare system. Caregiver factors associated with the development of PICS-F include female sex, spouse caregiver, low education level, pre-existing mental or physical illness, family history of mental illness, lack of social and professional support, and caregiving for more than 100 hours per month.[29] Healthcare-system or ICU-related factors are potentially modifiable, such as limited ICU visiting hours, patient perception of being near death, and communication skills of ICU physicians. Patient-related factors play only a small role in the development of PICS-F, according to the findings of the RECOVER study.[30]

The SCCM recommends family involvement in the care of ICU patients. However, these guidelines lack recommendations on how and when to screen family members and who is responsible for assessing and managing PICS-F. Although further research is required to validate screening tools for PICS-F, we recommend close monitoring of family member well-being and considering referral for psychotherapy if indicated.

Studies have shown that the following approaches are useful to improve both patient and family outcomes, resulting in a high level of family satisfaction and reduced family anxiety: creation of "open" ICUs, family witness of resuscitation efforts, ICU diaries, and proactive engagement of family members in patient care.[31,32] "Open" ICUs are characterized by flexible visiting policies in terms of hours, number or age of visitors, daily meetings with family members, healthcare providers performing tasks in front of family members, and redesigning units to ensure family comfort and sleep needs. Incorporating family members into ICU care and witnessing codes have been shown to reduce depression and PTSD risk at 3 and 12 months post discharge.[33] Most studies support the use of ICU diaries to document events chronologically, with entries from staff and family members and photographs of patients.[34]

Effective, structured communication strategies between staff and family members are also useful in reducing the risk of developing PICS-F. Useful approaches include conducting a family conference within 72 hours of ICU admission, ensuring consistent communication from different team members, and increasing the proportion of time spent listening rather than talking. Empathy is required to recognize the difficulties of being a surrogate decision-maker and having a critically ill or experiencing the impending loss of a loved one. Clinicians should identify opportunities to acknowledge and address family emotions, explore patient values and treatment preferences, explain the role of surrogate decision-makers, and affirm non-abandonment of the patient and family, even if the patient is dying.[35] These principles are summarized in the mnemonic "VALUE" (Value family statements, Acknowledge and Listen to family emotions, Understand patients as persons, and Elicit family questions) and have been shown to reduce PICS-F symptoms and increase family confidence in the care team.[36,37]

Evidence is limited or lacking regarding specific post-ICU interventions to reduce symptoms of PICS or PICS-F.[38] A major barrier to conducting large-scale, multi-site studies is the variability of post-ICU follow-up. Patients and caregivers, particularly in rural and underserved areas, may receive follow-up at different hospitals or healthcare systems from their initial ICU admission. In addition to rehabilitation and follow-up, we recommend that patients and

caregivers be provided access to support services such as home health care and the integration of care with the involvement of primary care physicians before discharge.

Whereas post-ICU clinics can provide interventions for the management of PICS-F, family-centered care remains inconsistent, with ambiguity in which healthcare professionals are responsible for managing PICS-F. This is a significant issue, as the effects of PICS-F may be long-lasting and profoundly impact caregivers' quality of life.

Meanwhile, clinical practice guidelines and protocols are needed for the diagnosis and management of the physical and neuropsychiatric sequelae of PICS. These interventions should be system-based yet individualized to each ICU survivor and developed through collaboration among intensivists, geriatricians, and multidisciplinary teams. A recovery care coordinator should also be designated to enable care coordination for the patient and caregivers from the ICU, as well as the implementation of individual care plans to facilitate a smooth transition of care from ICU to outpatient settings.[2)]

Once there is improved recognition and identification of PICS, further research is needed to create an evidence-based approach and model of care to effectively manage this condition. More research is also required to elucidate the mechanism for each component of PICS (cognitive, physical, and psychiatric), develop sensitive screening tools and specific confirmatory tests, and evaluate the effectiveness of preventive and treatment approaches for this condition.

CONCLUSION

There is limited awareness and under-recognition of PICS among clinicians despite its significant impact on the function and quality of life of patients and families. This condition may be prevented by encouraging early mobility in the ICU and minimizing the use of sedatives and antipsychotics. Once PICS is identified, rehabilitation, management, and follow-up should be carried out by a multidisciplinary team. Further research is required to strengthen the evidence base for the diagnosis and management of PICS and PICS-F.

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CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

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AUTHOR CONTRIBUTION

Conceptualization, MHA, SPT; Data curation, MHA, SPT; Methodology, MHA, SPT; Project administration, MHA, SPT; Supervision, SPT; Writing-original draft, MHA, SPT; Writing-review & editing, MHA, SPT.

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Association of the FRAIL Scale with Geriatric Syndromes and Health-Related Outcomes in Korean Older Adults

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Background: Owing to the growing older population, appropriate tools are needed for frailty screening in community-dwelling older people. We investigated the association between geriatric conditions and health-related outcomes using the five-item Fatigue, Resistance, Ambulation, Illnesses, & Loss of Weight (FRAIL) scale in a Korean rural community setting. **Methods:** We performed comprehensive geriatric assessments, including the FRAIL scale, in 1,292 community-dwelling people (mean age, 74.6 years) in the Aging Study of Pyeongchang Rural Area. These populations were prospectively followed up for 3 years to analyze the outcomes of death, institutionalization, disability, and quality of life. We investigated the association between frailty status and outcomes using the FRAIL scale. **Results:** According to the FRAIL scale, 524 (36.5%) participants were prefrail and 297 (23.0%) were frail. According to the adjusted model, the degree of frailty status was significantly associated with concurrent geriatric syndromes and 3-year incidences of mortality, institutionalization, and disability; Kaplan–Meier analysis showed significant differences in 3-year survival based on frailty status (92.6% for robust, 85.7% for prefrail, and 74.2% for frail; log-rank p<0.001). **Conclusion:** The five-item FRAIL scale can be used to screen for accompanying geriatric syndromes and is associated with the 3-year health-related outcomes in community-dwelling Korean older adults. From the public health perspective, this simple screening tool for frailty assessment might be applicable to older populations in Korea.

Key Words: Frailty, Outcome assessment, Health care, Public health, Mass screening

INTRODUCTION

South Korea is one of the fastest aging societies worldwide; moreover, the estimated life expectancy of Korean people is the highest (in 2030) among people from developed countries.[1)] However, according to the 2018 Korean Geriatrics Fact Sheet, 89.5% of older Korean adults had one or more chronic diseases and the annual national medical expenses for older adults accounted for 39.9% of the total medical expenses.[2)] With these changes in population, there is an overarching need to identify vulnerable older adults at high risk for conditions such as multimorbidity, polypharmacy, low economic status, cognitive impairment, and functional decline; moreover, growing evidence suggests that frailty is a core geriatric syndrome that is highly correlated with human aging, multimorbidity, and disability.[3-7)] Frailty is defined as a state of decreased physiological reserve associated with human aging and is a strong predictor of adverse health outcomes such as falls, fractures, loss of independence, disability, institutionalization, and death.[8,9)] Therefore, screening for frailty in older populations is a crucial step in delivering tailored multifaceted care for highly heterogeneous

geriatric care needs among individuals.[10]

Currently, the most commonly used frailty definitions in research[3,11] are the frailty phenotype and frailty index. These tools are less feasible for use in mass populations as they are resource intensive, research oriented, and especially troublesome to adapt to policies of resource-limited community settings.[12] As a screening measure, the Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight (FRAIL) scale, a self-reported screening instrument for frailty developed by Morley et al.,[13] is a valid method for use in communities. This short questionnaire is easy to administer, requires minimal time and resources, and has comparable performance in screening frailty. It has been validated in various populations and is a useful screening tool for identifying frail older adults.[13-15] The Korean version, the K-FRAIL scale, has been validated in the Korean population, especially in older adults in urban communities.[16,17] The FRAIL scale has been shown to have predictive validity for mortality in various studies.[18,19] However, other health outcomes such as disability or institutionalization require further investigation.[20]

Thus, this study examined the association between geriatric conditions and health-related outcomes such as mortality, institutionalization, and disability using the five-item FRAIL scale in rural community-dwelling Korean older adults.

MATERIALS AND METHODS

Study Population

We analyzed the records of participants in the Aging Study of Pyeongchang Rural Area (ASPRA) cohort, a population-based, prospective cohort study originally established in 2014 that included community-dwelling adult residents of Pyeongchang-gun, Gangwon Province, South Korea who were aged 65 years and older. Detailed information on the original study design and measurements in the ASPRA has been published elsewhere.[21] During annual assessments, the study population continuously increased with the expansion of the covered region of ASPRA among Pyeongchang-gun, with the inclusion and exclusion criteria remaining the same. Individuals were eligible for participation if they were (1) aged 65 years or older, (2) registered in the Community Healthcare Service, (3) ambulatory with or without an assistive device, (4) living at home, and (5) able to provide informed consent by themselves or their legal proxies. We excluded participants who were (1) living in nursing homes, (2) hospitalized, or (3) bedridden and receiving nursing home level care at home at the time of enrollment.

Between December 2014 and December 2017, 1,295 community-dwelling individuals were enrolled in the ASPRA cohort, which included over 90% of eligible people living in the study area. Among these older adults, we used records of 1,292 people who completed the K-FRAIL questionnaire. All participants underwent a comprehensive geriatric assessment every 12 months, while health-related outcomes, including death, institutionalization, and disability, were recorded every 3 months. The characteristics of the original ASPRA population were generally comparable to those of the general Korean rural population based on the Korea National Health and Nutrition Examination Survey.[21] The study protocol of the ASPRA cohort was approved by the Institutional Review Board of the Asan Medical Center (No. 2015-0673). Written informed consent was obtained from all participants.

Frailty Screening

We used the K-FRAIL questionnaire as a screening measure for frailty status. The K-FRAIL is based on the original FRAIL scale,[13] which has been validated in various populations and translated into Korean.[16] This simple screening tool of five self-reported items can be assessed in 2–3 minutes with no requirement for special equipment or sophisticated training. The questionnaire comprises five items:

(1) Fatigue (responses of "all of the time" or "most of the time" to the following question): "How much of the time during the past 4 weeks did you feel tired?"
(2) Resistance (positive response to the question): "By yourself and not using aids, do you have any difficulty in walking up 10 steps without resting?"
(3) Ambulation (positive response to the question): "By yourself and not using aids, do you have any difficulty in walking 300 m?"
(4) Illnesses (five or more self-reported physician diagnoses of hypertension, diabetes, cancer excluding minor skin cancer, chronic lung disease, heart attack, congestive heart failure, angina, asthma, arthritis, stroke, or kidney disease), and
(5) Loss of weight (> 5% in the past year).

We calculated the K-FRAIL score by combining the number of positive items and classified the participants as robust (0 points), prefrail (1–2 points), or frail (3–5 points).

Assessment of Geriatric Conditions

Trained nurses performed comprehensive geriatric assessments (CGAs) to evaluate geriatric conditions. Multimorbidity was defined as having two or more of the 11 physician-diagnosed illnesses such as angina, arthritis, asthma, cancer, chronic lung disease, congestive heart failure, diabetes, hypertension, heart attack, kid-

ney disease, and stroke. Polypharmacy was defined as regularly taking five or more medications.[22] Cognitive impairment was defined as a Korean version of the Mini-Mental State Examination score of < 24.[23] Depressive mood was defined as a Korean version of the Center for Epidemiological Studies Depression scale score of > 20.[24] Malnutrition risk was defined as a Mini-Nutritional Assessment-Short Form score of ≤ 11.[25] To assess physical function, we measured handgrip strength (kg) using a dynamometer (T.K.K. 5401 Grip-D; Takei, Tokyo, Japan) and averaged two measurements of the dominant hand.[21] We defined dysmobility as a slow gait (usual gait speed < 0.6 m/s from a timed 4-m walk).[26] We calculated the Short Physical Performance Battery (SPPB) score from three components: the ability to stand for up to 10 seconds with feet positioned in three ways (together side-by-side, semi-tandem, and tandem), the time to complete a 4-m walk, and the time to rise from a chair five times. The resultant SPPB scores ranged from 0 to 12, with higher scores indicating a higher level of function.[27] Sarcopenia was defined according to the Asian Working Group for Sarcopenia as follows: decreased muscle mass (decreased handgrip strength of < 26 kg for men and < 18 kg for women) and decreased physical performance (slow gait of < 0.8 m/s).[28] Disability was defined as requiring assistance in performing any of the seven activities of daily living (ADL; bathing, continence, dressing, eating, toileting, transferring, and washing face and hands) or 10 instrumental activities of daily living (IADL; food preparation, household chores, going out on a short distance, grooming, handling finances, laundry, managing own medications, shopping, transportation, and using a telephone).[21]

Outcome Measurements

This study defined major adverse health outcomes as death, institutionalization, and incidence of disability during the 3-year follow-up period. We defined disability as the requirement for assistance from another person in performing any one of the ADL or IADL.[21] Health-related quality of life was assessed during the follow-up period using the EuroQol-5D (EQ-5D).[29] An EQ-5D score decline over 3 years of > 0.2 was considered clinically meaningful.[30] To assess these outcome measures, all participants underwent structured interviews via phone calls every 3 months on institutionalization, death, and annualized follow-up assessments, including CGAs for ADL, IADL, and EQ-5D.

Statistical Analysis

To compare variables for baseline characteristics according to the frailty status derived from the K-FRAIL scale, we used Kruskal–Wallis and chi-square tests for continuous and discrete variables, respectively. To cross-sectionally assess the association between prevalent frailty and geriatric syndrome, we used logistic regression analysis with common geriatric syndromes as dependent variables and frailty status (robust, prefrail, and frail) as independent variables after adjusting for age and sex. For longitudinal outcome analysis, we used logistic regression analysis for health outcomes of mortality, long-term institutionalization, incidence of disability, and decline in EQ-5D score at 3 years from baseline, with frailty status (robust, prefrail, and frail) as dependent variables after adjusting age and sex. Mortality was further analyzed using Kaplan–Meier analysis, with log-rank tests and Cox proportional hazard regression analysis used to examine the statistical differences in survival according to the baseline frailty status. The restricted mean survival time was estimated as death at 40 months. Two-sided p-values < 0.05 indicated statistical significance in all analyses. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Baseline Characteristics according to Frailty Status based on the FRAIL Scale

As shown in Table 1, 471 (36.5%) participants were classified as robust, 524 (40.5%) as prefrail, and 297 (23%) as frail according to the K-FRAIL scale. The frail group was older, more likely to be female, more likely to be living alone, and had lower income than the other two groups ($p < 0.001$). The frail group also had a higher burden of multimorbidity and polypharmacy and was more likely to have depression and cognitive impairment than the other two groups ($p < 0.001$). Physical performance was worse and the prevalence of disability was higher in the frail group than in the other two groups ($p < 0.001$).

Associations between Frailty Status and Geriatric Conditions

In Table 2, frailty according to the FRAIL scale was associated with geriatric conditions after adjusting for age and sex. The frail group showed a significant association with multimorbidity (odds ratio [OR] = 2.24; 95% confidence interval [CI], 1.57–3.21), dysmobility (OR = 5.35; 95% CI, 3.58–7.97), malnutrition (OR = 4.09; 95% CI, 2.83–5.90), cognitive impairment (OR = 3.52; 95% CI, 2.36–5.25), depression (OR = 27.50; 95% CI, 11.09–68.19), and disability (OR = 3.12; 95% CI, 2.18–4.46).

Associations between FRAIL Scale and Health Outcomes

Longitudinal analysis showed that baseline frailty status significantly increased the risks of mortality (OR = 3.57; 95% CI, 1.69–7.54), institutionalization (OR = 2.42; 95% CI, 1.30–4.51), and disability at 3 years (OR = 3.04; 95% CI, 1.91–4.85) but not the

Table 1. Baseline characteristics according to frailty status in the Korean version of the FRAIL scale

	Robust (n = 471)	Prefrail (n = 524)	Frail (n = 297)	p-value[a)]
Age (y)	72.2 ± 5.2	74.6 ± 6.1	78.3 ± 6.3	< 0.001
Sex, female	188 (40.0)	312 (59.5)	217 (73.1)	< 0.001
Living alone	91 (19.3)	149 (28.4)	101 (34.0)	< 0.001
Low income	21 (4.5)	37 (7.1)	30 (10.1)	0.010
BMI (kg/m^2)	24.6 ± 3.3	24.5 ± 3.7	24.3 ± 3.8	0.534
Multimorbidity	139 (29.5)	210 (40.1)	168 (56.6)	< 0.001
Polypharmacy	73 (15.5)	118 (22.5)	107 (36.0)	< 0.001
Cognitive dysfunction	62 (13.2)	164 (31.3)	157 (52.9)	< 0.001
Depressive mood	6 (1.3)	49 (9.4)	87 (29.3)	< 0.001
At risk of malnutrition	1 (0.0)	20 (3.8)	43 (14.5)	< 0.001
SPPB score	9.7 ± 2.3	8.0 ± 2.8	5.0 ± 3.1	< 0.001
Dysmobility	61 (13.0)	133 (25.4)	169 (56.9)	< 0.001
Sarcopenia	78 (16.6)	185 (35.3)	145 (48.8)	< 0.001
ADL disability	17 (3.6)	76 (14.5)	86 (29.0)	< 0.001
IADL disability	111 (23.6)	149 (28.4)	176 (59.3)	< 0.001

Values are presented as mean±standard deviation or number (%).
FRAIL scale, Fatigue, Resistance, Ambulation, Illnesses, & Loss of Weight scale; BMI, body mass index; SPPB, Short Physical Performance Battery; ADL, activity of daily living; IADL, instrumental activity of daily living.
[a)]Kruskal–Wallis test.

Table 2. Associations between frailty status and geriatric conditions

Outcome	Level	Cases	OR[a)]	95% CI	p-value
Living alone (n = 341)	Robust (Ref)	91	-	-	
	Prefrail	149	1.13	0.82–1.56	0.462
	Frail	101	1.08	0.73–1.61	0.702
Low income (n = 88)	Robust (Ref)	21	-	-	
	Prefrail	37	1.43	0.81–2.52	0.220
	Frail	30	1.61	0.83–3.13	0.158
Multimorbidity (n = 517)	Robust (Ref)	139	-	-	
	Prefrail	210	1.33	1.01–1.75	0.047
	Frail	168	2.24	1.57–3.21	< 0.001
Dysmobility (n = 363)	Robust (Ref)	61	-	-	
	Prefrail	133	1.53	1.07–2.19	0.02
	Frail	169	5.35	3.58–7.97	< 0.001
Malnutrition (n = 64)	Robust (Ref)	1	-	-	
	Prefrail	20	2.29	1.72–3.06	< 0.001
	Frail	43	4.09	2.83–5.90	< 0.001
Impaired cognition (n = 383)	Robust (Ref)	62	-	-	
	Prefrail	164	1.96	1.38–2.79	< 0.001
	Frail	157	3.52	2.36–5.25	< 0.001
Depressive mood (n = 142)	Robust (Ref)	6	-	-	
	Prefrail	49	6.24	2.62–14.9	< 0.001
	Frail	87	27.50	11.09–68.19	< 0.001
Disability (n = 615)	Robust (Ref)	128	-	-	
	Prefrail	225	1.12	0.84–1.50	0.448
	Frail	262	3.12	2.18–4.46	< 0.001

OR, odds ratio; CI, confidence interval.
[a)]According to age, sex-adjusted logistic regression analysis.

deterioration of the quality of life (Table 3). The differences in 3-year mortality according to the FRAIL scale are shown in Fig. 1. The frail group had significantly lower estimated median survival (203 months) than the prefrail (410 months) and robust (357 months) groups at 30 months follow-up (all $p < 0.05$).

DISCUSSION

The results of this prospective study showed that frailty according to the K-FRAIL scale was associated with accompanying geriatric conditions and with 3-year health-related outcomes such as mortality, institutionalization, and disability in community-dwelling Korean older adults.

The K-FRAIL scale showed high sensitivity and negative predictive value in differentiating vulnerability from robustness; however, the quantification of frailty status with respect to various health-related outcomes has been understudied. The clinical implications of our findings are that frail individuals identified using the K-FRAIL scale have an elevated disability, institutionalization, and mortality profile. Therefore, these frail individuals might benefit from further comprehensive geriatric assessments and multidomain interventions. The K-FRAIL scale is correlated with the previously validated frailty index and other frailty measures.[16] Our results provide evidence for the adequacy of the FRAIL scale, including its associations with health-related outcomes, as well as identifying individuals with a high burden of geriatric conditions in rural communities.

A previous systematic review and meta-analysis of 3–5 studies demonstrated high ADL (pooled OR = 9.82, compared with robustness) and IADL (pooled OR = 2.50, compared with robustness) disability risks for frailty according to the FRAIL scale.[20]

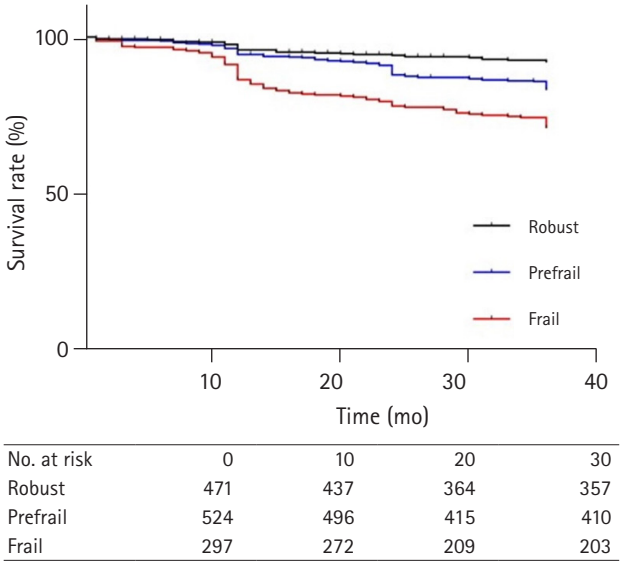

Fig. 1. Differences in 3-year mortality according to the FRAIL (Fatigue, Resistance, Ambulation, Illnesses, & Loss of Weight) scale.

Table 3. Association between FRAIL scale and health outcomes

Outcome	Level	OR[a]	95% CI	p-value
Mortality	Robust (Ref)	-	-	
	Prefrail	1.53	0.78–2.98	0.214
	Frail	3.57	1.69–7.54	< 0.001
Institution	Robust (Ref)	-	-	
	Prefrail	1.69	0.96–2.95	0.068
	Frail	2.42	1.30–4.51	0.005
Incidence of disability	Robust (Ref)	-	-	
	Prefrail	1.58	1.10–2.27	0.013
	Frail	3.04	1.91–4.85	< 0.001
Mortality or institution	Robust (Ref)	-	-	
	Prefrail	1.70	1.09–2.67	0.02
	Frail	3.14	1.90–5.18	< 0.001
Mortality, institution, or incident disability	Robust (Ref)	-	-	
	Prefrail	1.67	1.22–2.29	0.001
	Frail	3.78	2.52–5.66	< 0.001
EQ-5D decrease of ≥ 0.2	Robust (Ref)	-	-	
	Prefrail	1.44	0.67–3.09	0.350
	Frail	0.57	0.19–1.69	0.315

FRAIL scale, Fatigue, Resistance, Ambulation, Illnesses, & Loss of Weight scale; OR, odds ratio; CI, confidence interval; EQ-5D, EuroQol-5D.
[a]For 3-year outcomes according to age, gender-adjusted logistic regression analysis.

Our results using the K-FRAIL scale were consistent with previous results. Similar to our results, another meta-analysis of three studies showed that both frailty (pooled OR = 3.53, compared with robustness) and prefrailty (pooled OR = 1.75 compared with robustness) were significantly associated with higher mortality risk.[18] Although previous studies less often focused on institutionalization as an outcome of the FRAIL scale, we found that frailty according to the K-FRAIL scale was associated with an increased risk of long-term institutionalization. The results of our cross-sectional analysis showed that frailty was highly associated with depressed mood, dysmobility, risk of malnutrition, and multimorbidity. The fact that the FRAIL scale encompasses comorbidities should be considered when interpreting multimorbidity rates.

However, the longitudinal analysis showed that baseline frailty status was not associated with future QOL. Although the mechanism is not clear in the current study, the lack of association between the FRAIL scale and future QOL decline might be due to the characteristics of the FRAIL scale rather than the clinical construct of frailty itself, with a previous study being able to produce meaningful changes in frailty status from the same study population using EQ-5D as an anchor.[30]

Our study has several strengths and limitations. The limitation was that the results were obtained from underserved older populations in rural areas, which restricted their generalizability to the general population of Korea. However, this cohort study included more than 90% of eligible older adults, with high completion rates of geriatric parameters in the study population. The outcomes of functional changes were available in our study population because the study population remained relatively stable, with < 5% of older adults immigrating or emigrating from the area except for morbidity or mortality, with the study area rather distant from major cities in Korea. Residents received medical and preventive care almost exclusively from regional community health posts operated by the National Health Service. Therefore, we could examine long-term clinical outcomes such as mortality and institutionalization.

In conclusion, frailty according to the five-item FRAIL scale was associated with geriatric syndromes and 3-year health-related outcomes in rural community-dwelling Korean older adults. In the context of public health, this simple screening tool for frailty assessment might be applicable to older populations in Korea.

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CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

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AUTHOR CONTRIBUTION

Conceptualization, HL, JYC, HWJ, IYJ; data acquisition, IYJ; data analysis, HL, JYC, IYJ; writing, original draft, HL, JYC, HWJ, IYJ; writing review and editing, HL, JYC, HWJ, JYB, EL, IYJ.

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Comparison of Human Interpretation and a Rule-Based Algorithm for Instrumented Sit-to-Stand Test

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Background: The five times sit-to-stand test (5STS) is one of the most commonly used tests to assess the physical performance of lower extremities. This study assessed the correlation between human interpretation ($5STS_{human}$) and a rule-based algorithm ($5STS_{rule}$) using instrumented 5STS with two sensors. **Methods:** We analyzed clinical records of 148 patients who visited the geriatric outpatient clinic of Asan Medical Center between December 2020 and March 2021 and underwent physical performance assessment using the electronic Short Physical Performance Battery (eSPPB) protocol. For STS, time-weight and time-distance curves were constructed using a loadcell and light detection and ranging (LiDAR). We manually assessed the grids of these curves to calculate $5STS_{human}$, while $5STS_{rule}$ used an empirical rule-based algorithm. **Results:** In the study population, the mean $5STS_{human}$ and $5STS_{rule}$ times, i.e., 12.2±0.4 and 11.4±0.4 seconds, respectively, did not differ significantly (p=0.232). Linear regression analysis showed that $5STS_{human}$ and $5STS_{rule}$ were positively correlated (β=0.99, R^2=0.99). The measures also did not differ (p=0.381) in classifying sarcopenia according to the Asian Working Group Society criteria, with C-indices of 0.826 for $5STS_{human}$ and 0.820 for $5STS_{rule}$. **Conclusion:** An empirical rule-based algorithm correlated with human-interpreted 5STS and had comparable classification ability for sarcopenia.

Key Words: Sarcopenia, Physical functional performance, Aging, Biomarkers

INTRODUCTION

Accumulating evidence suggests the clinical importance of assessing the physical performance of the lower extremities in older adults as a diagnostic marker,[1-3] outcome predictor,[4-6] and clinical outcome measure.[7-9] For example, the assessment of the physical performance of the lower extremities is an essential component in diagnosing sarcopenia, a common geriatric syndrome defined as a state of decreased muscle mass, muscle strength, and/or physical performance.[2,10] Longitudinal studies have shown that decreased physical performance of the lower extremities is associated with falls, functional decline, and mortality.[11-15] Furthermore, meaningful changes in physical performance following treatment are considered crucial efficacy measures in intervention studies targeting sarcopenia or frailty.[16,17]

Among the various tools used to assess the physical performance of lower extremities, the five times sit-to-stand test (5STS) is one of the most commonly used tests owing to its advantages in clinical implementation.[18] The test can be performed in clinical environments with restricted time and space.[19] 5STS is included in the consensus definition for sarcopenia, either as a separate test (≥ 12 seconds for impaired physical performance) or as a component of

the Short Physical Performance Battery (SPPB) score (with scores ≤ 9 indicating impaired physical performance).[2] While most studies have adopted 5STS using a simple chair and stopwatch, researchers have also developed instrumented approaches using sensors of varying modalities to automatically or semi-automatically acquire 5STS measurements to minimize inter-rater variability and collect additional information during test protocols.[18-21]

We previously developed a multi-sensor kiosk to semi-automatically perform SPPB using light detection and ranging (LiDAR) and loadcells to facilitate physical performance assessments in both clinical and research settings.[21] Electronic SPPB (eSPPB) was comparable to SPPB performed manually by a single experienced examiner.[21] In addition, continuous parameters derived from eSPPB were used to classify frailty in geriatric outpatients.[22] The eSPPB protocol used two sensors, i.e., a loadcell and LiDAR, as well as a rule-based algorithm, to determine the sit and stand maneuvers.[21] Although the correlation between the instrumented 5STS in eSPPB and manual 5STS was assessed semi-quantitatively (score ranging from 0 to 4), the validity of the rule-based algorithm has not yet been proven.

Hence, we assessed the correlation between human interpretation ($5STS_{human}$) and the rule-based algorithm ($5STS_{rule}$) to determine instrumented 5STS time in geriatric outpatients at a tertiary academic hospital. We also compared the characteristics of these two 5STS measurement methods in classifying sarcopenia.

MATERIALS AND METHODS

Study Design and Participants

This study was performed as a retrospective cross-sectional review of clinical records of 165 consecutive outpatients who visited the geriatric outpatient clinic of Asan Medical Center between December 2020 and March 2021 and underwent physical performance examination, including the eSPPB protocol. Community-dwelling and ambulatory patients with or without a walking aid were considered for the test because eSPPB involves gait speed measurement. When performing eSPPB, patients with an estimated life expectancy of less than 1 year owing to advanced malignancy or those with decompensated heart failure or end-stage renal disease, those unable to walk without other persons' assistance, or those with cognitive dysfunction who could not perform eSPPB according to instructions were excluded. We also removed 17 duplicate records of patients who underwent eSPPB more than once and included 148 records in our final analysis. Among the study population, 5STS and sarcopenia were analyzed in 126 patients who underwent geriatric assessments, including demographic, medical, and sarcopenia parameters.

The protocol for this study was reviewed and approved by the Institutional Review Board of the Asan Medical Center (No. 2021-0519). Because of the retrospective nature of the study, the requirement for informed consent was waived. We maintained the confidentiality of patients' health information and performed our analysis after anonymizing the dataset. In this study, the researchers complied with the ethical rules for human experimentation stated in the Declaration of Helsinki.[23]

Measurement of 5STS

Test protocol and sensor composition

For 5STS, the patients were instructed to perform five sit-to-stand maneuvers as quickly as possible, with their arms crossed on the shoulders of the opposite side. To acquire 5STS data, we combined two sensors to simultaneously measure the seated weight and position of participants in real time (Fig. 1). First, a loadcell measured the weights of the sitting participants every 10 ms and produced a time-weight curve. Second, a LiDAR sensor measured the distance from the corner of the chair to the buttock of participants to produce a time-distance curve. These sensors were connected to a computer using the XBee wireless protocol (Digi International Inc., Hopkins, MN, USA) and controlled by a software that performed the standardized eSPPB protocol (Dyphi Inc., Daejeon, Korea).[14,21] For the categorization of 5STS, we employed the widely used criterion for SPPB, ranging from 0 to 4 (0 for 5STS > 60 seconds, 1 for 16.7–60 seconds, 2 for 13.7–16.7 seconds, 3 for 11.2–13.7 seconds, and 4 for ≤ 11.2 seconds).

$5STS_{human}$

Graphs of the time-weight curve and time-distance curve were interpreted by HWJ who was blinded to demographic and clinical parameters of the participants. For interpretation, 200-ms vertical

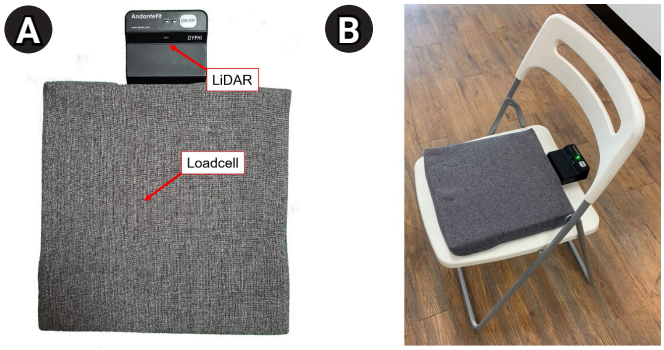

Fig. 1. (A) Layout of the sensors (loadcell and light detection and ranging [LiDAR]) used in the study. (B) Sensor attached to a common chair without an armrest.

grids were introduced in the graphs to determine the time points of (1) the buttock of participants detached from the chair as the starting point and (2) participants completed five chair stands as the finish point (Fig. 2) to best mimic eye observed 5STS. The duration between the start and finish points ($5STS_{human}$) was calculated.

$5STS_{rule}$

For $5STS_{rule}$, we used both time-weight and time-distance curves to define four conceptual phases of 5STS: (1) sit, weight ≥ 10 kg; (2) sit-to-stand, weight < 10 kg and distance < 30 cm; (3) stand, weight < 1.5 kg and distance > 30 cm; and (4) stand-to-sit, weight ≥ 1.5 kg. The cut-off values for weight and distance were established empirically. Based on these rules, the starting point of the test was defined as an initial seated weight decrement of < 10 kg, while the ending point of the test was indicated by the fifth increment of distance exceeding 30 cm (Fig. 2).

Sarcopenia Assessments

Muscle mass was assessed using bioelectrical impedance analysis (InBody S10; InBody, Seoul, Korea). Appendicular skeletal muscle (ASM) was estimated by summing the muscle masses of the four extremities. ASM was divided by height^2 (m^2) to calculate the skeletal muscle mass index (SMI) to adjust for anthropometric differences among patients. Grip strength of the dominant hand was measured using a JAMAR hydraulic handgrip dynamometer (Patterson Medical, Warrenville, IL, USA) with the elbow flexed at 90° and the participant in a seated position. For walking speed, we measured the 4-m usual gait speed, with a separate 1-m acceleration distance that was excluded from the speed calculation.[24]

Sarcopenia was determined according to the 2019 Asian Working Group for Sarcopenia (AWGS) guidelines, in which individuals with low muscle mass (SMI < 7.0 kg/m^2 for men and < 5.7 kg/m^2 for women), low muscle strength (grip strength < 28 kg for men and < 18 kg for women), or low physical performance (gait speed < 1.0 m/s) were considered as having sarcopenia.

Statistical Analysis

Descriptive statistics were analyzed for demographic and geriatric parameters of the study population. T-tests and chi-square tests were used to compare continuous and categorical variables, respectively. We assessed the intraclass correlation coefficient (ICC) between $5STS_{human}$ and $5STS_{rule}$ and used a scatterplot with linear regression analysis to assess the correlation between $5STS_{human}$ and $5STS_{rule}$. Bland-Altman plots and linear regression analysis of the means and differences were used to evaluate the potential biases between these two measures, with the absolute difference as a dependent variable and the average as an independent variable.[25] The kappa statistic was calculated to assess the agreement between categorized $5STS_{human}$ and $5STS_{rule}$ scores. The performance of $5STS_{human}$ and $5STS_{rule}$ in classifying sarcopenia was assessed by receiver operating characteristic (ROC) analysis and comparisons of C-indices. Two-sided p-values < 0.05 were considered statistically significant. Analyses were performed using Stata 16.0 (StataCorp, College Station, TX, USA).

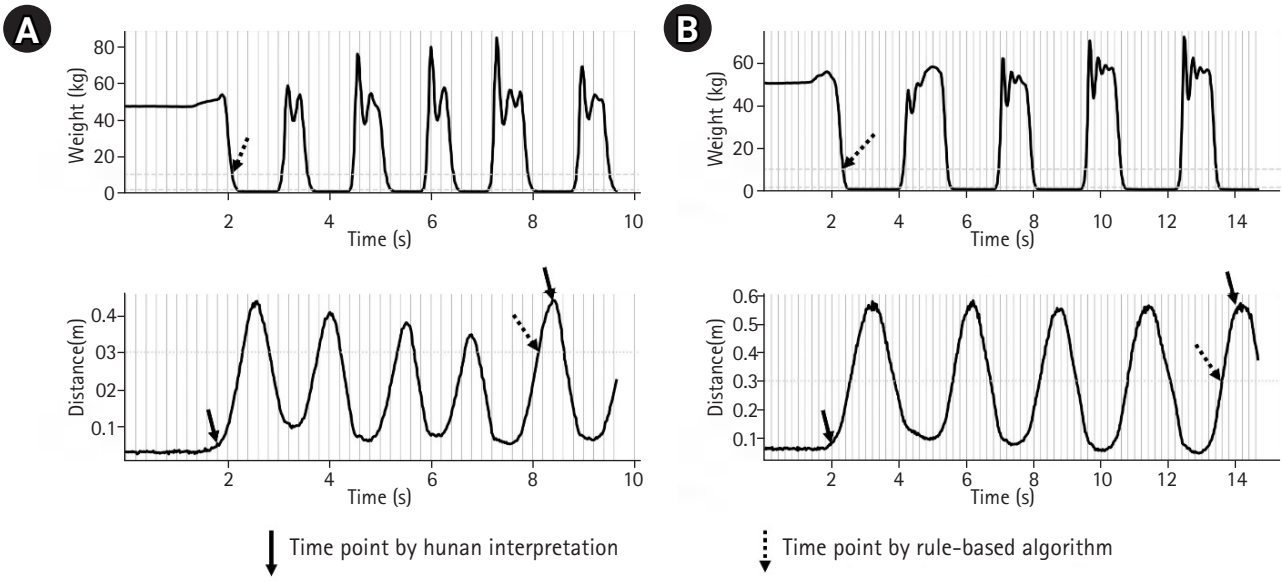

Fig. 2. Two examples of sit-to-stand tests. (A) A patient with $5STS_{human}$ and $5STS_{rule}$ times of 6.4 seconds and 6.0 seconds, respectively. (B) A patient with $5STS_{human}$ and $5STS_{rule}$ times of 11.2 seconds and 11.3 seconds, respectively. $5STS_{human}$, human-interpreted five times sit-to-stand test time; $5STS_{rule}$, rule-based five times sit-to-stand test.

RESULTS

Basic Characteristics

In the study population, the mean age was 76.3 ± 7.6 years, and 88 outpatients (59.5%) were female (Table 1). The $5STS_{human}$ time was significantly shorter ($p = 0.035$) in men (11.0 ± 3.3 seconds) than in women (12.9 ± 6.4 seconds). Similarly, the $5STS_{rule}$ time was significantly shorter ($p = 0.026$) in men (10.3 ± 3.2 seconds) than in women (12.2 ± 6.0 seconds). Age was positively correlated with both $5STS_{human}$ (standardized beta [β] = 0.30, $p < 0.001$) and $5STS_{rule}$ (β = 0.29, $p < 0.001$). The worst quintile values of $5STS_{human}$ and $5STS_{rule}$ were 14.8 and 13.7 seconds, respectively.

Agreements between $5STS_{human}$ and $5STS_{rule}$

The absolute difference between STS by $5STS_{human}$ (12.2 ± 0.4 seconds) and $5STS_{rule}$ (11.4 ± 0.4 seconds) was 0.74 ± 0.62 seconds, and it did not differ significantly ($p = 0.232$). The correlations between these two parameters are shown in Fig. 1. Linear regression analysis showed that $5STS_{human}$ and $5STS_{rule}$ were positively correlated (β = 0.99, $R^2 = 0.99$, $p < 0.001$, $5STS_{human} = 1.05 \times 5STS_{rule} + 0.18$). The ICC of the average measures between $5STS_{human}$ and $5STS_{rule}$ was 0.98 ($p < 0.001$). A proportional bias between $5STS_{human}$ and $5STS_{rule}$ was observed using linear regression (Fig. 3, β = 0.45, $R^2 = 0.19$, $p < 0.001$).

Since 5STS is commonly performed as a component of SPPB, we compared the categorical scores between $5STS_{human}$ and $5STS_{rule}$ (Table 2). The kappa statistic between the two measures was 0.88, suggesting a substantial agreement.

Performance of Classifying Sarcopenia

Among 126 patients who underwent assessments for sarcopenia, 34 (27.0%) met the AWGS criteria for sarcopenia. Specifically, 58 (46.0%) had low muscle mass, 42 (33.3%) had low gait speed, and 33 (26.2%) had low grip strength. In ROC analysis (Fig. 4), the C-indices for classifying sarcopenia according to the AWGS criteria from $5STS_{human}$ and $5STS_{rule}$ were 0.826 (95% confidence interval [CI], 0.749–0.903) and 0.820 (95% CI, 0.743–0.897), respectively, showing no statistically significant difference ($p = 0.381$). The cut-off times with maximal sensitivity+specificity for sarcopenia were ≥13.8 seconds for $5STS_{human}$ and ≥12.8 seconds for $5STS_{rule}$.

Table 1. Basic characteristics of the study population

	Male (n = 60)	Female (n = 88)	p-value
Age (y)	75.1 ± 9.5	77.0 ± 5.9	0.132
$5STS_{human}$ (s)	11.0 ± 3.3	12.9 ± 6.4	0.035
$5STS_{rule}$ (s)	10.3 ± 3.2	12.2 ± 6.0	0.026
BMI[a)] (kg/m^2)	23.7 ± 3.2	25.4 ± 6.5	0.088
ASM/ht^2[a)] (kg/m^2)	7.1 ± 0.85	5.8 ± 0.7	< 0.001
Grip strength[a)] (kg)	34.0 ± 8.5	20.3 ± 5.4	< 0.001
Gait speed[a)] (m/s)	0.96 ± 0.28	0.88 ± 0.28	0.070
Hypertensiona) (%)	25 (53.2)	53 (67.1)	0.120
Diabetes[a)] (%)	15 (31.9)	33 (41.8)	0.271
Fall history in 1 year[a)] (%)	4 (8.5)	15 (19.0)	0.122

Values are presented as mean±standard deviation or number (%).
$5STS_{human}$, human-interpreted five times sit-to-stand test time; $5STS_{rule}$, rule-based five times sit-to-stand test time; BMI, body mass index; ASM/ht^2, appendicular skeletal muscle mass adjusted by height.
[a)]Available from 47 male and 79 female patients.

DISCUSSION

The results of this study demonstrated the correlation between $5STS_{human}$ and $5STS_{rule}$ from instrumented STS. Moreover, the two approaches showed similar abilities in detecting sarcopenia. While the mean difference between $5STS_{human}$ and $5STS_{rule}$ was not significant in the study population, $5STS_{rule}$ tended to be smaller than $5STS_{human}$, with intrinsic characteristics of empirically determined rule-based criteria defining the phase shift between the sit-to-stand and standing states, in contrast to human interpretation, which tried to capture the maximal peak of the distance between the LiDAR sensor and patients. To our knowledge, this study is the first attempt to adopt a type of sensor fusion method using both LiDAR and loadcells to assess 5STS.

Previous studies have attempted to capture the dynamics of 5STS using different sensors such as accelerometers, motion capture devices, force plates, depth cameras, and RGB cameras.[18-20,26-29] Shukla et al.[19] showed that a force plate or loadcell-embedded seat could more accurately capture 5STS than depth or RGB cameras, with a smaller mean error size compared to a human expert examiner. In the study,[19] the results of the phase-determination rule-based algorithm interpreting the time-weight curve of a loadcell-embedded chair were generally similar, although researchers adopted a percent cut-off value to define phases rather

Table 2. Agreement between categorized $5STS_{human}$ and $5STS_{rule}$ scores (0 for 5STS >60 s, 1 for 16.7–60 s, 2 for 13.7–16.7 s, 3 for 11.2–13.7 s, and 4 for ≤11.2 s)

$5STS_{rule}$	$5STS_{human}$				
	1	2	3	4	Total
1	20	0	0	0	20
2	2	8	0	0	10
3	0	9	17	1	27
4	0	0	6	85	91
Total	22	17	23	86	148

$5STS_{human}$, human-interpreted five times sit-to-stand test time; $5STS_{rule}$, rule-based five times sit-to-stand test.

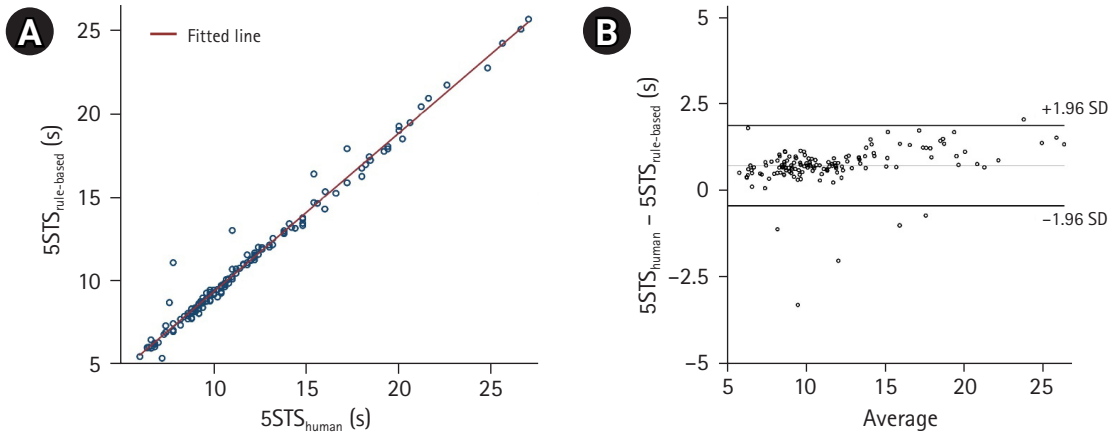

Fig. 3. (A) Scatterplot showing 5STS$_{human}$ and 5STS$_{rule}$ times and their correlations according to a fitted line. (B) Bland-Altman plot of 5STS$_{human}$ and 5STSrule times. 5STS$_{human}$, human-interpreted five times sit-to-stand test time; 5STS$_{rule}$, rule-based five times sit-to-stand test.

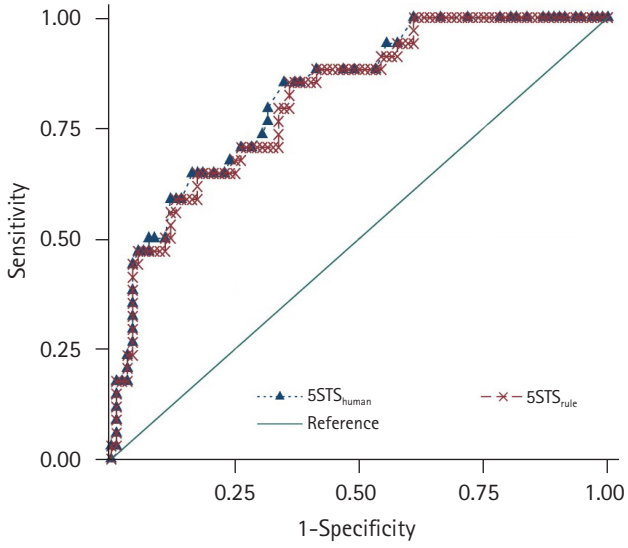

Fig. 4. Receiver operating characteristic curves of 5STS$_{human}$ and 5STS$_{rule}$ in classifying sarcopenia according to the Asian Working Group Society guideline. 5STS$_{human}$, human-interpreted five times sit-to-stand test time; 5STS$_{rule}$, rule-based five times sit-to-stand test.

than the absolute weight value as used in the present study. Although a single loadcell sensor could reliably measure STS, as demonstrated by Shukla et al.[19], we noted that rule-based algorithms based on loadcell data were sometimes less reliable in capturing STS phases, especially in frail and underweight female patients in real-world settings. To address this issue, we added a LiDAR set at 45° to further acquire time-distance data by tracking the distance between the sensor and buttock of the participants. In contrast to non-wearable sensor approaches, studies have also adopted wearable sensors.[26,27] However, these studies generally focused on exploring new features to assess fall risk rather than measuring 5STS per se.

We observed that the rule-based interpretation provided more rapid 5STS, with an absolute difference of 0.7 seconds, compared to that for 5STS$_{human}$. A previous report showed a minimally detectable 5STS difference of 2.5 seconds;[30] thus, the difference between 5STS$_{human}$ and 5STS$_{rule}$ is less likely to affect the interpretation of the physical performance of patients in clinical assessments. Our observation of agreement between the categorized scores of 5STS$_{human}$ and 5STS$_{rule}$ further supports the comparability of these two approaches. However, to alleviate possible concerns regarding differences owing to the slightly biased interpretation of 5STS$_{rule}$, regression equation between 5STS$_{human}$ and 5STS$_{rule}$ can be performed to calculate the estimated 5STS$_{human}$ using the automatically measured 5STS$_{rule}$.

Although we used an empirically established rule-based algorithm in the current study, there is still room for improvement in optimally mimicking 5STS$_{human}$. Given sufficient data from patients with a wide spectrum of physical performance and expert annotation on time-weight and time-distance curves, machine learning can be used to develop better algorithms. With the development of improved algorithms, instrumented 5STS can be more confidently adopted both as a screening tool and as an outcome measure with minimal inter-rater variability for intervention schemes targeting sarcopenia.

The strengths of this study are the implementation of sensors and algorithms for real-world geriatric outpatients and the clinical assessments of sarcopenia. While eSPPB using these sensors has been in clinical use since 2019, raw weight-time and distance-time data other than the eSPPB score were not stored in the hardware until a software update in December 2020 while the updated software allowed the current post-hoc analysis for 5STS using stored raw eSPPB data. Similar to a previous study using continuous parameters of eSPPB for classifying frailty,[22] explorations of human

kinetic features with newer algorithms using already installed sensors may identify additional physical biomarkers related to sarcopenia and frailty.

The present study had some limitations. Most importantly, STS was performed only using the instrument while manually measured 5STS using the human eye and stopwatch was not available since the study was a retrospective analysis using stored eSPPB data. However, as previously demonstrated,[19] 5STS by human observation is unlikely to affect the results of the current study. In addition, as a single-center study in a tertiary academic hospital in Korea, the generalizability of the results is limited. The statistical significance of the absolute difference between $5STS_{human}$ and $5STS_{rule}$ cannot be ruled out if the study was performed with sufficiently large sample size. To address these issues, future studies with larger populations of diverse ethnicities are warranted.

In conclusion, $5STS_{human}$ and $5STS_{rule}$ times using a LiDAR and loadcell were correlated in older geriatric outpatients. Both measures agreed with the categorical scores of the SPPB and had comparable classification ability for sarcopenia. Our findings support clinical evidence for adopting instrumented 5STS in clinical practice and research for older adults.

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CONFLICT OF INTEREST

Hee-Won Jung, Seongjun Yoon, and Hyunchul Roh cofounded Dyphi Inc., a startup company on sensor technology. The other researchers claim no conflicts of interest.

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AUTHOR CONTRIBUTIONS

Conceptualization, HWJ, SY, HR; Data curation, HWJ, SY, IYJ, HR; Funding acquisition, IYJ; Investigation, HWJ, SY, HR; Methodology, HWJ, SY, IYJ, HR; Writing-original draft, HWJ; Writing-review & editing, all.

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Frailty among Older Adults Living in Nursing Homes in Indonesia: Prevalence and Associated Factors

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Background: Frailty syndrome is a predictor of all-cause mortality among older adults living in nursing homes. However, data on the prevalence of frailty among individuals living in nursing homes, particularly in middle-income countries, are limited. Thus, this study aimed to determine the prevalence of frailty and identify its associated factors among older adults living in nursing homes in Indonesia. **Methods:** This cross-sectional study of older adults living in six nursing homes in Indonesia was conducted between May and December 2019. Data on demographic characteristics, physical activity (Physical Activity Scale for the Elderly), cognitive status (Abbreviated Mental Test), nutritional status (Mini Nutritional Assessment Short-Form), depression (Geriatric Depression Scale), comorbidity, frailty state (Cardiovascular Health Study criteria), dietary pattern (24-hour food recall), handgrip strength, and gait speed were evaluated. Bivariate and multivariate analyses were performed to identify factors independently associated with frailty. **Results:** This study recruited a total of 214 participants with a mean age of 73.68±4.30 years. The prevalence rates of frailty and malnutrition were 46.5% and 58%, respectively. The results showed that physical frailty was associated with malnutrition (odds ratio=4.23; 95% confidence interval, 1.730–10.380). **Conclusion:** Frailty was prevalent and strongly associated with malnutrition among older adults living in nursing homes in Indonesia.

Key Words: Older adult, Frailty syndrome, Nursing home

INTRODUCTION

Frailty significantly affects older adults. Frailty syndrome is characterized by decreased physiological reserves caused by multi-dimensional deficits associated with the aging process. Older adults with frailty are at an increased risk of falls and health issues, including disability, which are correlated with increased morbidity and mortality.[1-4] The prevalence of frailty ranges from 4.0% to 59.1%, with an overall prevalence rate of 10.7%.[5] A previous study conducted in Indonesia reported a frailty prevalence rate of 25.2% among older adults in the community[6] compared with 29%–87.5% among individuals living in nursing homes in Western countries based on the frailty screening criteria.[7] Frailty is an important factor among older individuals living in nursing homes. A systematic review by Zhang et al.[8] showed that frailty was a predictor of all-cause mortality among older individuals living in nursing homes. Therefore, frailty screening and multi-disciplinary intervention strategies must be conducted immediately to prevent poor outcomes and reduce mortality rates among older individuals living in nursing homes.

The risk factors for frailty syndrome include aging, low physical activity, weight loss, poor nutrition, unhealthy lifestyle habits, poor

living environment, comorbidities, polypharmacy, genetics, and female sex. These factors are interrelated, form a cycle, and cause conditions such as chronic malnutrition, inflammation, and disruption in hormone regulation and coagulation pathways.[1)]

In middle-income countries, including Indonesia, malnutrition and poor energy and protein intake are significant challenges among older adults.[9,10)] Nursing homes in Indonesia are mostly funded by the government, private companies, and charity organizations. Moreover, older adults in Indonesia usually live with their children and grandchildren; thus, few older adults are sent by the family or are admitted to nursing homes. Usually, only older adults with many comorbidities and poor financial support move to nursing homes.

Previous studies have found that older individuals living in nursing homes present with cognitive impairment and depression.[8)] Studies on the association between malnutrition and physical frailty among nursing home residents, particularly in Asia, where dietary patterns and leisure-time physical activities differ between countries, are limited. The development of intervention programs for older individuals requires the identification of important predictors of frailty. Therefore, this study aimed to determine the prevalence of frailty and identify its associated factors among older adults living in nursing homes in Indonesia.

MATERIALS AND METHODS

Study Site and Cohort

This cross-sectional study included 214 older individuals living in six nursing homes in Jakarta and Banten Provinces, Indonesia from May 2019 to July 2019. The inclusion criteria were nursing home residents aged >60 years who were willing to participate in the study. We excluded subjects with severe dependency or inability to walk or grab a dynamometer or who could not understand questionnaires owing to health problems. The Research Ethics Committee of Universitas Indonesia approved this study (No. KET-1190/UN2.F1/ETIK/PPM.00.02/2019). Written informed consents were obtained from all subjects.

Data Collection

We collected data on demographic characteristics such as age, ethnicity, anthropometric measurements (including body weight and height estimated using knee height), body mass index (BMI), and the Comprehensive Geriatric Assessment domains. The participants were screened for depression using the 15-item Geriatric Depression Scale, with scores >10 indicating depression. Malnutrition was assessed using the Mini Nutritional Assessment Short-Form,[11)] with scores <7 indicating malnutrition. Cognitive status was assessed using the Abbreviated Mental Test (AMT), with scores <8 indicating cognitive impairment. Physical activity was measured using the Physical Activity Scale for the Elderly (PASE), with a cut-off score >270 suggesting normal physical activity. Functional status was evaluated using the Barthel Index for activities of daily living. Scores of 100, 61–99, and ≤60 indicated independence, mild and moderate dependency, and severe dependency, respectively. We defined multimorbidity in this study as the presence of more than two comorbidities.

We defined frailty based on the Cardiovascular Health Study (CHS) criteria,[12)] which comprises the following items: weight loss, weak grip strength, slow gait speed, exhaustion, and low energy expenditure. Frailty was defined as meeting three or more of the five criteria, while non-frailty was defined as meeting none to two criteria. Handgrip strength was assessed three times using a handgrip dynamometer (Jamar Hydraulic Hand Dynamometer Model J00105; Lafayette Instrument, Lafayette, Indiana) using the dominant hand at 30-minute intervals between each measurement. We recorded the highest value of the three measurements. Nutritionists performed a 24-hour food recall to calculate the daily total energy and protein intakes.

Statistical Analysis

We performed statistical analyses using IBM SPSS Statistics for Windows, version 20.0 (IBM, Armonk, NY, USA). We first assessed variables for homogeneity before performing the statistical analysis. Continuous variables are expressed as mean ± standard deviation (SD), and categorical variables are expressed as frequencies and percentage. A bivariate analysis of categorical variables that might be related to frailty, such as sex, age, low physical activity, cognitive impairment, malnutrition, depression, multimorbidity, energy, and protein intake, was performed using chi-square tests. The multivariate analysis included variables with p values <0.25 in the bivariate analysis. We performed the multivariate analysis using logistic regression (backward method) to identify factors associated with frailty among nursing home residents. Variables with $p \leq 0.05$ were considered statistically significant.

RESULTS

This study recruited a total of 214 participants with a mean age of 73.68 ± 4.30 years. Approximately 2%, 51.3%, and 46.7% of participants were categorized as fit, pre-frail, and frail, respectively. The characteristics of the participants are listed in Table 1. Based on the results of the bivariate analysis, age, malnutrition, and depression were correlated with frailty syndrome (Table 2). The results of the final multivariate analysis (Table 3) showed that malnutrition was

Table 1. Participants' characteristics

Variable	All (n = 214)	Non-frail group (n = 115)	Frail group (n = 99)
Sex, female	152 (71)	65 (56)	89 (89)
Age (y)	73.7 ± 4.3	77.1 ± 7.9	72.9 ± 6.6
Multimorbidity	34 (16.2)	14 (12)	20 (20)
Comorbidity			
Hypertension	87 (41.9)	42 (36)	45 (45)
Diabetes mellitus	45 (21.9)	15 (13)	30 (30)
Coronary artery disease	30 (14)	10 (8)	20 (20)
Stroke	10 (5.7)	6 (5)	4 (4)
Nutritional status			
Malnutrition	84 (39)	60 (52)	24 (24)
Normal	126 (58.8)	38 (33)	88 (88)
BMI (kg/m^2)	22.3 ± 4.1	22.6 ± 3.5	21.3 ± 4.6
Cognitive status			
Suspected cognitive impairment	46 (21.4)	26 (22)	20 (20)
Normal	168 (78)	86 (74.7)	82 (82.8)
Depression or suspected	44 (20)	30 (26)	14 (14.1)
Dependency state			
Independent	208 (97)	110 (95)	98 (99)
Mild to moderate dependency	6 (3)	5 (5)	1 (1)
Handgrip strength (kg),	16 (2–40)	19.4 (14–23)	12.9 (8–17.1)
Physical activity, PASE score (kcal/wk)	170.0 ± 13.5	189.8 ± 12.5	152.4 ± 9.0
Walking speed (m/s)	0.66 ± 0.34	0.84 ± 0.30	0.23 ± 0.03
Energy intake (kcal/day)	1,245.3 ± 72.0	1,288.0 ± 218.0	1,062.0 ± 315.0
Protein intake (kg BW/day)	36.1 ± 18.0	38.2 ± 9.1	32.2 ± 11.1

Values are presented as number of participants (%) or mean±standard deviation or median (range).
BMI, body mass index; PASE, Physical Activity Scale for the Elderly; BW, body weight.

Table 2. Bivariate analysis of factors associated with frailty syndrome

Variable	OR (95% CI)	p-value
Sex	0.84 (0.95–1.62)	0.340
Age > 70 y	2.07 (1.00–4.27)	0.010
Low physical activity	3.87 (0.61–24.52)	0.067
Cognitive impairment	0.80 (0.44–1.44)	0.433
Malnutrition	2.28 (1.49–3.51)	< 0.001
Depression	1.72 (1.16–2.53)	0.017
Multimorbidity	1.46 (0.90–2.27)	0.236
Energy intake	1.45 (0.80–3.31)	0.310
Protein intake	2.15 (0.50–4.60)	0.280

OR, odds ratio; CI, confidence interval.

Table 3. Multivariate analysis of factors associated with frailty syndrome

Variable	OR (95% CI)	p-value
Malnutrition	4.23 (1.73–10.38)	0.002
Older age	2.83 (0.80–2.96)	0.080
Depression	8.30 (0.78–87.40)	0.070

OR, odds ratio; CI, confidence interval.

associated with frailty syndrome among older individuals living in nursing homes.

DISCUSSION

Approximately 83.8% of participants had < 2 comorbidities, similar to the results of a previous study on individuals in the community that reported ≤ 2 comorbidities in 77% of older adult participants in the community.[6] Hypertension was the most common disease in the present study, a finding consistent with the 2013 National Basic Health Research data showing that hypertension was the most frequent health issue among older adult individuals in Indonesia.[13] Although the proportion of participants with comorbidities was relatively small, most had a low level of physical activity and reduced handgrip strength and walking speed. The level of physical activity among the participants was lower than that among older adults in the community (PASE score: 170 [range, 156.5–184 kcal/week] vs. 322 [range, 42–2,704 kcal/week]).[14] Ismail et al.[15] reported a higher physical activity level in an older adult population in Malaysia, with an average PASE score of 664.3 kcal/

week. The median handgrip strength of participants in the present study (16 kg [range, 2–40 kg]) was lower than the normal handgrip strength of older individuals according to the CHS criteria (which was in accordance with the BMI of female participants) and the Asian Working Group for Sarcopenia ($\geq$ 18 kg).[16] The low walking speed in this population (0.66 m/s) was even lower than that reported in a study in community (0.85 m/s)[14] and outpatient (0.85 m/s) settings.[17] A 4-year cohort study of 3,018 participants aged > 64 years who lived in the community in China reported that women had a faster walking speed at 0.96 (SD = 0.21) m/s.[18]

Frailty is common among nursing home residents based on their low handgrip strength and walking speed. A study conducted in Bali, Indonesia reported a frailty prevalence rate of 43.3% compared with 69.3% and 55.6%, respectively, among individuals in Spain[19] and China.[20] However, the cohorts in these previous studies were significantly older than the cohort in the current study. We observed a significantly higher prevalence of frailty in a relatively younger population, a finding that requires further assessment to facilitate the early diagnosis and treatment of frailty.

We did not observe an association between age and frailty, contrary to the results of a study on older Indonesian community-dwelling individuals, in which age > 70 years was significantly correlated with frailty (odds ratio [OR] = 5.27; 95% confidence interval [CI], 2.92–9.52).[16] Along with the aging process, physiological changes such as the activation of certain inflammatory processes, changes in body composition (decreased fat-free muscle mass), hormonal imbalances, and insulin resistance, which can eventually contribute to the development of frailty syndrome, have also been observed among older adult individuals.[4]

However, we observed no relationship between low levels of physical activity and frailty syndrome, unlike the finding reported in the study by Peterson et al.,[21] where participants with a low level of physical activity or sedentary lifestyle had higher risks of frailty (OR = 1.45; 95% CI, 1.04–2.01). The differences in study results can be attributed to the low physical activity level in most participants.

We observed no association between cognitive impairment and frailty syndrome in the present study, contrary to the report by Chen et al.[22] who showed that impaired cognitive function was independently associated with frailty syndrome (OR = 2.73; 95% CI, 1.09–6.83). This discrepancy might be attributed to the fact that most participants had normal cognitive status and different instruments (AMT vs. Mini-Mental State Examination [MMSE]) were used. Moreover, the Singapore Longitudinal Aging Study showed differences in the proportions of participants with different frailty states who presented with cognitive decline (MMSE score < 26). In particular, the pre-frail and frail older adult groups with cognitive impairment (older people with cognitive frailty, excluding dementia) had increased risks of disability, worse quality of life, and mortality.[23]

The results of this study showed that malnutrition alone was associated with frailty. Malnutrition in the context of poor nutrition and obesity can be correlated with frailty syndrome by increasing the composition of fatty tissues in the body, which may further increase the production of pro-inflammatory cytokines such as interleukin-6 and C-reactive protein. Another study in Indonesia reported that older adults had low energy and protein intake.[13] Therefore, malnutrition was associated with frailty. However, these are two distinct entities. Both are reversible; thus, nursing home residents with malnutrition or pre-frailty and frailty should receive early treatment to prevent these conditions from worsening. As we excluded subjects who could not perform frailty tests or answer questionnaires, the limitation of this study is that the prevalence of frailty in this population could be under-reported.

In conclusion, a significant proportion of older adults living in nursing homes presented with frailty. Malnutrition was significantly associated with physical frailty. Therefore, periodic evaluations of the nutritional and frailty status of older adults living in nursing homes are needed to assess the development of malnutrition and frailty. Moreover, further studies are warranted to develop intervention programs for malnourished, pre-frail, and frail individuals living in nursing homes.

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CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

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AUTHOR CONTRIBUTION

Conceptualization, AR; Data curation, AI; Funding acquisition, AR; Investigation, AR, AI; Methodology, AR; Project administration, AI; Supervision, AR, ND, M; Writing–original draft, AI, AR, SSL; Writing–review & editing, AR.

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Quality of Life and Functional Independence of Hip Fracture Patients: Data from a Single Center Follow-Up Study in Sri Lanka

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Background: Data on the functional outcomes of hip fracture patients in Sri Lanka are limited. As this information is required for the design of long-term care plans, we assessed the physical activities (activities of daily living [ADL]) and quality of life (QoL) of hip fracture survivors in Sri Lanka. **Methods:** A group of 180 consecutive patients with incident hip fractures admitted to a tertiary care center in Southern Sri Lanka were followed up for 12 months. The Sinhala versions of the Barthel Index, 36-Item Short-Form Survey, and Mini-Mental State Examination were used to assess ADL, QoL, and mental status, respectively. **Results:** Of the 180 patients (149 women), 107 underwent surgery. An initial sharp decline and partial recovery of ADL and QoL were observed among patients with hip fractures. Furthermore, patients who underwent surgical treatment showed faster recovery of ADL and QoL than did patients who were managed conservatively. Similarly, patients who did not have complications during the hospital stay showed faster recovery of ADL and QoL than did patients with one or more complications. **Conclusions:** Hip fractures profoundly affected both ADL and QoL, and recovery remained incomplete at 12 months post fracture. Patients who underwent surgery had a faster recovery than did patients who did not undergo surgery; similarly, patients without complications also had a faster recovery than did those with complications.

Key Words: Quality of life, Sri Lanka, Functional status, Hip fractures

INTRODUCTION

Hip fracture is considered the most ominous clinical outcome of osteoporosis because of the high mortality, morbidity, and healthcare costs.[1,2] Patients with hip fractures have higher mortality rates during their hospital stays and for years after discharge.[2] Following a hip fracture, mortality is higher during the initial 6 months than the next 6 months, and compared to that in an age-matched normal population, this increased mortality persists for several years.[3,4] Johnston et al.[5] observed that mortality among patients aged > 85 years with hip fractures tended to return to the level in the background population after 2–5 years, whereas increased mortality persisted beyond 8 years post fracture among those < 85 years. Apart from mortality related to hip fractures, deaths due to comorbidities also account for the increased mortality apparent after such fractures.[6]

In addition to excess mortality, hip fractures are also associated with high healthcare costs, which vary among countries. A Canadian study in 2013 estimated a mean attributable cost in the first year after fracture of Can$36,929 among women and Can$39,479 among men, translating to Can$282 million in directly attributable healthcare costs in Ontario and Can$1.1 billion in Canada annually.[7] Further, a similar study in New Zealand[8] reported a combined total cost over 2 years post operation for hip fracture of

NZ$66,637,355. According to Cheung et al.,[9] the direct cost of hip fractures will increase from US$9.5 billion in 2018 to US$15 billion in 2050 in nine member countries of the Asian Federation of Osteoporosis Societies.

Aside from the economic implications, impairment of physical function and quality of life (QoL) frequently occurs among hip fracture survivors. Nearly 40%–50% of hip fracture survivors have limitations in at least one activity of daily living (ADL) 12 months after a fracture.[10,11] Studies have also shown a sharp reduction in physical function and QoL immediately after hip fracture, with partial recovery later.[12-14] The high physical dependency in the post-fracture period is an added burden on caregivers and family members, leading to the institutionalization of patients who are severely affected. Lin and Lu[15] observed that 56.7% of caregivers in Taiwan reported "feeling exhausted" because of the added workload of caring for family members with hip fractures.

Asia, with the expanding elderly population, will become the epicenter of hip fractures. On the basis of epidemiological data from four Asian countries—Singapore, Malaysia, Thailand, and Hong Kong—Lau et al.[16] predicted that hip fractures would become a major public health challenge in this region. Cheung et al.[9] predicted that the number of hip fractures would increase from 1,124,060 in 2018 to 2,563,488 in 2050 in the Asian region. Despite these alarming predictions, the preparedness of these countries to meet the challenges of hip fractures is not clearly evident. In South Asian countries, epidemiological data on patients with hip fracture related to causation and short- and long-term clinical outcomes are sparse compared to those in Western countries. This information gap is a major limitation to resource allocation and the design of health and social care pathways. More studies are needed to inform the relevant authorities to make changes in the current health and social care services to face the predicted burden of hip fractures in these countries.

This 12-month follow-up study assessed the physical dependence and QoL of patients admitted with incident hip fractures to a tertiary care center in Southern Sri Lanka. After an extensive search of the major electronic databases, we were unable to identify previous studies examining the QoL of hip fracture survivors in Sri Lanka.

MATERIALS AND METHODS

This prospective cohort study did not include a parallel control group. Follow-up data from a hip fracture registry maintained since September 2017 were used for this analysis. One hundred eighty patients with incident fragility hip fractures (FHFs) admitted consecutively to a tertiary care center (Teaching Hospital, Karapitiya, Galle) in the southern province of Sri Lanka were followed up for 12 months. Written informed consent was obtained from all patients or their immediate family members before recruitment. This study included only those patients with new hip fractures resulting from a simple fall (from a standing height or less) and excluded patients with high-energy (non-fragility) fractures and readmissions for the same fracture. The study was approved by the Ethics Review Committee of the Faculty of Medicine, University of Ruhuna, Sri Lanka (No. 19.12.2016: 3.3).

In this study, we applied the validated Sinhala version of the 36-Item Short-Form Survey (SF 36)[17] to assess the QoL at discharge and at 3, 6, and 12 months post-fracture. We assessed ADL using the Sinhala version of the Barthel Index (BI)[18] at five time points: 1 week before the fracture; at the time of discharge; and at 3, 6, and 12 months after the fracture. Finally, we assessed the mental state of the patients at discharge using the validated Sinhala version of the Mini-Mental State Examination (MMSE).[19] Members of the research team visited the relevant wards regularly to collect data, and patients were followed up with regular telephone calls and in-person meetings during subsequent hospital visits. Some patients were interviewed at their residences to collect data.

On the basis of the information on comorbidities gathered from patients during the interview and collected from case notes, we calculated the age-adjusted Charlson Comorbidity Index (ACCI) by weighting comorbid conditions and adding additional points for each decade over 40 years of age.[20,21]

Data are presented as mean ± standard deviation, median (interquartile range), or number (percentage). We applied the chi-square and independent t-test for categorical and numerical data, respectively, and used analysis of variance (ANOVA) to compare two groups. Statistical significance was set at $p < 0.05$.

RESULTS

Sociodemographic and Clinical Characteristics of Patients with an FHF

The study cohort included 180 consecutive patients (149 women) with incident hip fractures admitted during the study period to the Teaching Hospital, Karapitiya, Galle, Sri Lanka. All fractures occurred following minor falls from a standing height or less. Table 1 presents the sociodemographic and clinical characteristics of the patients with FHF according to the management of their hip fractures. Seven patients (59%) underwent surgery; the others were managed conservatively (non-surgically). Five patients died while in the hospital, whereas 28 died during the 12-month follow-up. Furthermore, 53 patients (29%) developed one or more complications during their hospital stay. These complications included

pressure ulcers (14 patients, 7.8%), respiratory tract infections (10 patients, 5.6%), urosepsis (19 patients, 10.6%), and acute myocardial ischemia (4 patients, 2.2%) (Table 2).

Table 1. Sociodemographic and clinical characteristics of patients with surgically and conservatively managed fragility hip fractures

Characteristic	FHF patient management (n = 180)	
	Surgical (n = 107)	Conservative (n = 73)
Sex, female	90 (84.1)	59 (80.8)
Age (y)	73.6 ± 8.0	82.0 ± 8.5
History of previous fragility fracture	8 (7.5)	6 (8.2)
Family history of fragility fracture	9 (8.4)	7 (9.6)
Smoking	7 (6.5)	7 (9.6)
Alcohol consumption	9 (8.4)	10 (13.7)
Use of glucocorticoids	32 (29.9)	19 (26.0)
Comorbid conditions		
Vascular diseases	39 (36.4)	32 (43.8)
Dementia	2 (1.9)	10 (13.7)
COPD/bronchial asthma	23 (21.5)	22 (30.1)
Rheumatic diseases	3 (2.8)	3 (4.1)
Peptic ulcer disease	14 (13.1)	4 (5.5)
Liver disease	5 (4.7)	5 (6.8)
Diabetes mellitus	15 (14.0)	21 (28.8)
Renal diseases	0 (0)	4 (5.5)
Hypertension	34 (31.8)	35 (47.9)
Hyperlipidemia	10 (9.3)	3 (4.1)

Values are presented as number of patients (%) or mean±standard deviation.
COPD, chronic obstructive pulmonary disease.

Physical Dependence and QoL of Patients with Hip Fractures during 12 Months Post-fracture

An initial sharp decline and partial recovery in ADL were observed among patients with hip fractures (Table 3). A similar pattern was evident in the total score and physical and psychological domains of the SF-36 (Table 4). In addition, the ADL score at 12 months was below the pre-fracture score.

Determinants of QoL at 12 Months

In the correlation analysis, age and ACCI were found to be inversely related to the two domains of QoL, whereas BI measured at five time points showed positive correlations (Table 5).

Analysis of the trends of BI and SF-36 values over time showed a steady increase in all indices in the group of patients who underwent surgery. In contrast, no major improvement in QoL indices was observed, as ADL decreased slightly over time (Table 6) in pa-

Table 3. Changes in the physical dependence of patients with hip fractures during 12 months post-fracture

Time of assessment	Barthel index	Physically dependent subjects[a)]
Before fracture (n = 180)	100 (95–100)	10 (5.6)
At discharge (n = 175)	30 (20–45)	175 (100)
At 3 months (n = 172)	40 (15–60)	172 (100)
At 6 months (n = 159)	55 (20–80)	152 (95.6)
At 12 months (n = 147)	85(30–90)	87 (59.2)

Values are presented as median (interquartile range) or number of patients (%).
[a)]Barthel index <90.

Table 2. Comparisons of complications between surgically and conservatively managed patients with fragility hip fractures

Complications	FHF patient management (n = 180)		p-value[a)]
	Surgical (n = 107)	Conservative (n = 73)	
Pressure ulcer	3 (2.8)	11 (15.1)	0.003
Wound infection	1 (0.9)	8 (11.0)	0.002
Urinary tract infection	7 (6.5)	12 (16.4)	0.034
Acute renal failure	1 (0.9)	2 (2.7)	0.353
Cardiac complication	1 (0.9)	4 (5.5)	0.068
Pneumonia	2 (1.9)	8 (11.0)	0.009
Myocardial infarction	2 (1.9)	2 (2.7)	0.697
Cerebrovascular accident	2 (1.9)	3 (4.1)	0.369
Pulmonary embolism	0 (0)	3 (4.1)	0.034
Deep venous thrombosis	0 (0)	3 (4.1)	0.034
Gastrointestinal bleeding	3 (2.8)	0 (0)	0.149
Number of complication(s)			
0	91 (85.0)	36 (49.3)	< 0.001
1	12 (11.2)	21 (28.8)	< 0.001
2+	4 (3.7)	16 (21.9)	< 0.001

Values are presented as number of patients (%).
[a)]Chi-square test.

Table 4. Changes in SF-36 total scores and physical and psychological domains

Measure	At discharge (n = 175)	At 3 months (n = 172)	At 6 months (n = 159)	At 12 months (n = 147)
Physical health	9.6 (6.7–11.7)	19.3 (10.2–22.7)	33.8 (13.1–45.6)	44.6 (16.5–56.7)
Psychological health	13.3 (11.7–15.0)	28.3 (15.4–31.7)	44.6 (15.4–58.8)	60.8 (14.2–73.0)
Total SF-36 score	11.0 (7.9–12.8)	22.0 (11.1–25.7)	34.0 (10.7–49.9)	40.0 (8.1–60.4)

Values are presented as median (interquartile range).
SF-36, 36-item Short-Form Health Survey questionnaire.

Table 5. Correlations of two domains of the SF-36 at 12 months with selected variables

Variable	SF-36 at 12 months		p-value[a)]
	Physical health domain	Psychological health domain	
Age	-0.53	-0.48	< 0.001
ACCI	-0.42	-0.38	< 0.001
BI before fracture	0.33	0.35	< 0.001
BI at discharge	0.61	0.59	< 0.001
BI at 3 months	0.86	0.85	< 0.001
BI at 6 months	0.89	0.89	< 0.001
BI at 12 months	0.90	0.90	< 0.001
MMSE at discharge	0.42	0.38	< 0.001

SF-36, 36-item Short-Form Health Survey questionnaire; ACCI, age-adjusted Charlson Comorbidity Index; BI, Barthel Index; MMSE, Mini-Mental State Examination.
[a)]Pearson correlation.

Table 6. Trends in BI and SF-36 scores during follow-up according to the type of treatment and the presence or absence of complications

	At discharge	At 3 months	At 6 months	At 12 months	p-value[a)]	
					Within-group	Intergroup
Surgical	(n = 106)	(n = 105)	(n = 103)	(n = 101)		
SF-36 physical	11.3 ± 2.9	24.7 ± 8.8	41.6 ± 9.9	51.7 ± 10.8	< 0.001	< 0.001
SF-36 psychological	14.1 ± 2.5	33.8 ± 9.9	54.9 ± 14.0	66.8 ± 14.4	< 0.001	< 0.001
Conservative	(n = 69)	(n = 67)	(n = 56)	(n = 46)		
SF-36 physical	5.9 ± 2.5	9.8 ± 4.0	11.1 ± 6.6	11.5 ± 6.2	< 0.001	
SF-36 psychological	10.8 ± 3.4	12.7 ± 3.9	12.2 ± 5.7	12.5 ± 7.8	< 0.001	
BI						
Surgical BI	37.7 ± 10.4	56.0 ± 14.7	68.7 ± 15.5	85.8 ± 12.0	< 0.001	< 0.001
Conservative BI	24.1 ± 9.7	17.0 ± 7.5	16.3 ± 7.6	16.6 ± 10.0	< 0.001	
No complications	(n = 122)	(n = 121)	(n = 117)	(n = 116)		
SF-36 physical	9.9 ± 3.8	21.0 ± 10.6	34.5 ± 15.7	42.4 ± 20.3	< 0.001	> 0.001
SF-36 psychological	13.3 ± 2.9	28.7 ± 12.9	44.5 ± 22.6	54.1 ± 26.6	< 0.001	> 0.001
BI	33.3 ± 13.1	45.2 ± 23.6	53.1 ± 30.0	63.8 ± 37.2	< 0.001	< 0.001
With complications	(n = 53)	(n = 51)	(n = 42)	(n = 31)		
SF-36 physical	7.5 ± 3.4	13.7 ± 7.4	20.6 ± 16.5	26.5 ± 19.0	< 0.001	
SF-36 psychological	11.6 ± 3.6	18.4 ± 10.7	26.7 ± 23.0	33.6 ± 28.7	< 0.001	
BI	26.5 ± 11.7	24.2 ± 16.8	23.7 ± 22.5	25.0 ± 31.0	< 0.001	

Values are presented as mean±standard deviation.
BI, Barthel Index; SF-36, 36-item Short-Form Health Survey questionnaire.
[a)]Analysis of variance (ANOVA).

tients who were managed conservatively. We observed similar trends for the groups of patients with one or more or no complications during their hospital stay (Table 6).

DISCUSSION

This analysis revealed a sharp decline in ADL and QoL after a hip

fracture and a gradual but partial recovery over the next 12 months. The ADL score of patients with FHF at 12 months did not reach the pre-fracture level, and nearly 60% still had a limitation of at least one ADL function at 12 months post fracture.

We observed that age and comorbidity negatively impacted QoL at 12 months post hip fracture, whereas ADL, both pre-and post-fracture ADL, and MMSE score at discharge showed positive influences on QoL. Patients managed surgically showed steady improvements in both ADL and QoL over the next 12 months compared with patients who were managed non-surgically. Similarly, patients without complications during hospital stay showed greater recovery of ADL and QoL than did patients with complications.

Physical dependence and poor QoL after hip fracture are common observations, and the findings of the current study are consistent with those reported previously. Analyzing a large cohort of 10,325 patients, Gjertsen et al. [22] noticed a marked reduction in QoL, and 58% of patients reported walking difficulty at 12 months post fracture. Hall et al.[10] also observed reduced QoL, difficulties in maintaining balance, and reduced physical activity in patients with hip fracture compared to those in age-matched controls. Furthermore, patients with hip fractures were unable to achieve pre-fracture mobility and independence. Many other studies have also reported the negative impact of hip fractures on QoL and physical function, including those by Milte et al.,[23] Prieto-Alhambra et al.,[12] Tarride et al.,[24] Lim,[25] and Amarilla-Donoso et al.[13]

In this study, age and comorbidity negatively affected the QoL of patients with hip fractures, whereas cognition and function (represented by MMSE) and independence in ADL positively affected the QoL of patients with hip fractures. Furthermore, patients treated surgically and those without complications had better outcomes. Amarilla-Donoso et al.[13] also reported that health-related QoL (HRQoL) scores at 1-month post-fracture was related to pre-fracture BI, depression, and surgery type. The influence of pre-fracture BI and MMSE on the QoL of hip fracture survivors has also been reported by others.[26] While Gjertsen et al.[22] and Milte et al.[23] showed the influence of age on the outcome of patients with hip fractures, Tarride et al.[24] found that, among many predictors, mobility was a strong predictor of QoL in these patients. Moreover, although they observed a partial recovery of HRQoL after 1 month, it remained below the pre-fracture level even 36 months post-fracture.

The positive association between ADL and QoL suggests the need for caregivers to focus on interventions that enhance the physical independence of patients with hip fractures. Unlike age and comorbidities, ADL is a modifiable determinant of QoL. Thus, attempts must be made to improve the QoL of these patients by improving their ADL. However, this concept needs to be tested in an interventional study before implementation.

Our observations reconfirm the debilitating nature of hip fractures. Although a gradual improvement in both ADL and QoL is observed during the first year, patients did not reach pre-fracture ADL, and their QoL remained lower. Furthermore, nearly 58% of patients were not fully physically active at 12-month post-fracture. Poor QoL and ADL make patients with hip fractures a burden for their families and caregivers.[15]

Only 59% of patients in our study group had undergone surgery. The reasons for non-surgical management included advanced age, higher comorbidity, and lack of consent for the procedure. The ADL and QoL at each follow-up were greater among patients who had undergone surgery than among those who were managed conservatively. Compared with non-surgical management, surgery, particularly when performed early, showed advantages related to mortality, ADL, and QoL in hip fracture patients.[27] Yoon et al.[28] reported higher cumulative mortality rates for up to 2 years and a higher prevalence of non-functional ambulatory state among hip fracture patients managed conservatively than among those who had undergone surgery. Furthermore, higher rates of complications (12.5% vs. 6.6%) and mortality (7.4% vs. 1.7%) were observed among hip fracture patients managed conservatively than among those managed surgically.[29]

In the current study, all patients were followed up for 12 months post-fracture, except for 33 patients who died during the 12-month follow-up. This can be considered a strength of this study. The study, however, was limited to one area of the country; thus, studies of similar nature from other parts of the country are needed before generalization of the results. Another limitation was that we did not assess other measurements of physical function such as gait speed or chair rise in this study.

In conclusion, hip fractures led to a rapid decline in ADL and QoL immediately after the event, with a gradual but partial recovery during the first 12 months post-fracture. We observed significant differences in the ADL and QoL between surgically and conservatively treated patients and between those who did and did not have complications. On the basis of these findings, we urge relevant authorities to take steps to increase the rate of surgical treatment for patients with hip fractures. To achieve this, the barriers and limitations of surgical treatment should be assessed and the necessary steps be taken to address them. Furthermore, steps should also be taken to avoid post-fracture complications. Most complications can be avoided by adhering to proper nursing practices, venous thromboembolism prophylaxis, and early mobilization.

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CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

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AUTHOR CONTRIBUTIONS

Conceptualization, TA, SL, JL, GA; Data curation, TA; Formal analysis, TA, SL; Funding acquisition, TA, SL; Investigation, TA; Methodology, TA, SL, JL, GA; Project administration, TA, SL, JL, GA; Supervision, SL, JL, GA; Writing-original draft, TA, SL; Writing-review & editing, TA, SL.

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Functional Assessment of Driving Capacity of Older Drivers Compared with Non-older Drivers Using Clinical Evaluations and Driving Simulations

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Background: This study used various tools, including a self-assessment questionnaire, the Clinical Assessment of Driver-Related Skills (CADReS), and a driving simulation, to discriminate between older and non-older drivers. **Methods:** We evaluated driving habits, driving-related health behaviors, and morbidities using a self-assessment questionnaire and examined visual, motor, and cognitive functions using the CADReS and a vehicle simulator of four junction scenarios that are typical of accidents involving older drivers. The areas under the receiver operating characteristic curves (AUCs) were calculated to compare the age-related discriminating ability of these tools between older (≥65 years) and non-older participants. **Results:** Thirty of the 40 participants (75%) were older. Older drivers were slower than non-older drivers according to the rapid walking pace (8.0 vs. 6.1 seconds), and their cognitive function was poorer based on the trail-making test (117 vs. 51 seconds). While driving on the vehicle simulator, the rate of violating traffic rules was higher and the maximal velocity was slower in the older group than in the non-older group. The AUC values for CADReS and driving simulation outcomes ranged from 0.59 to 0.95, while the rapid walking pace, trail-making test, and velocity of the left turn at an acute junction in the dark showed high discriminatory power (AUC>0.9). **Conclusions:** The rapid walking pace and trail-making test in CADReS, as well as the driving simulation, were useful tools to discriminate between older and non-older drivers.

Key Words: Automobile driving, Cognition, Aged, Motor capacity, Simulation training

INTRODUCTION

The growth of the aging population has led to an increasing number of older drivers. Perception in vision and hearing and cognitive and psychomotor skills are attenuated during aging; hence, older drivers experience visual impairment, cognitive decrements, reduced judgment ability in complex traffic environments, and medical disorders.[1] Age appears to contribute to increased road collisions as older drivers have a higher fatality rate in vehicle crashes owing to multiple chronic medical conditions and frailty than younger drivers.[2]

Healthcare providers should advise older drivers to stop driving or help them continue driving safely using bespoke evaluation tools to improve the fitness of older drivers.[3] On-road testing is an acceptable standard method to assess driving capacity; however, it is time-consuming and expensive to set up various test courses and

can be inappropriate for older drivers who may cause dangerous situations during the test.[4-6] Therefore, vehicle simulators are accepted as adequate tools to test driving capacity with regard to aptitude and performance. Driving simulation shows potential for use in the testing and training of older drivers. Vehicle simulators are also reportedly a safer and more economical method than on-road tests for assessing the driving capacity of older drivers.[4] However, the validity of vehicle simulators varies with simulator models and specific driving tasks; moreover, vehicle simulators have not been validated as a reliable tool for evaluating the driving capacity of older drivers.[7]

Available online or office-based simple screening tools are valid and reliable methods for assessing fitness to drive.[8] Self-assessment tools for the screening of older drivers at risk of unsafe driving include testing driver safety, a 15-item self-rating driving questionnaire, the American Automobile Association (AAA) Drivers 65 Plus, the Driving Decisions Workbook, and the Fitness-to-Drive Screening Measure.[3] The Driving Behavior Questionnaire is also a reliable tool for measuring older drivers' self-reported aberrant driving behaviors.[8] As a more objective measure, the Clinical Assessment of Driver-Related Skills (CADReS), an office-based assessment tool, has been widely used to indirectly measure crash risk in key areas of vision, cognition, and motor/sensory function. Functional abilities are reportedly more important than age in screening older drivers at risk.[9]

Instead of on-road tests, objective and subjective assessment tools can be used to evaluate driving capacity of older drivers compared with the driving capacity of young drivers. We hypothesized that the driving capacity of older drivers would be inferior to that of young drivers. We evaluated the driving capacity, including sensory, motor, and cognitive skills, of older drivers using three different assessment tools (self-assessment questionnaire, CADReS, and vehicle simulator) and screened valid assessment tools by comparing their results to those of non-older drivers.

MATERIAL AND METHODS

Study Participants

Older drivers (aged 65 years and over) were recruited among visitors at a senior welfare center located in Anyang City, and non-older drivers (aged below 65 years) were recruited among workers at Yongsan Electronics Market in Seoul, South Korea. The inclusion criterion was a valid Korean driver's license. The exclusion criteria were not driving or having a history of seizure for at least 1 year before participation. The participants were classified as older or non-older drivers. This study was conducted at the Mini Driving Simulation Center in Seoul between November 11, 2019 and 20, 2019.

Development of the Self-assessment Questionnaire

We developed a self-assessment questionnaire to evaluate driving habits, driving-related health behaviors, and morbidities based on the *Clinician's Guide to Assessing and Counseling Older Drivers*.[3] The questionnaire comprises 52 questions: 5 on demographic characteristics, 22 on driving habits, 5 on health behaviors, and 20 on chronic medical conditions that may affect driving. The assessment was administered as a personal interview survey performed directly after the driving simulation test.

CADReS

The present study used the CADReS, developed by the American Medical Association, as a second-step evaluation.[3] We assessed visual acuity and field; evaluated motor function using the rapid walking pace test and manual tests of motion range; and tested cognitive function using the maze test, trail-making test part B, clock-drawing test, and Korean-Montreal Cognitive Assessment (KMoCA). The assessment was conducted by two transport engineers at the Korea Transportation Safety Authority (KOTSA) who were trained to conduct interviews and assess driving-related functions by an emergency medicine specialist based on the *Clinician's Guide to Assessing and Counseling Older Drivers*.[3] The survey required approximately 30 minutes to complete, including an introduction to the purpose and methods of the assessment.

Driving Simulation Setting

The driving simulation was conducted using a compact driving simulation (CDS; Inno Simulation Co. Ltd, Seoul, Korea) at the Yongsan Laboratory in the University of Seoul. The CDS comprises a steering wheel, pedals (accelerator, brake), gears, seats, and an instrument panel as parts of the actual vehicle. Three beam projectors are connected to three computers displayed on each screen to prevent frame drop owing to multiple displays. In addition, three display panels are attached to the CDS to display the left-side mirror, right-side mirror, and room-mirror screen to make the driving experience as realistic as possible (Fig. 1).

Virtual driving data were recorded using the vehicle simulator Log Data, a function provided by UC-win/Road (FORUM8 KOREA, Anyang, Korea). This function automatically collects driving time, driving speed, driving distance, acceleration and deceleration speeds, brake power, revolutions per minute, steering wheel rotation angle, and one-way location.

Development of the Driving Simulation Scenarios

The driving simulation for older and non-older participants was

Fig. 1. View of the compact driving simulation and visual display.

performed using four junctions as follows: a right turn at an acute junction, going straight at an acute junction, pedestrian present at the right turn at a typical junction, and a left turn at an acute junction in the dark. The four junction scenarios were developed based on the analysis of accidents involving older drivers at urban junctions obtained from the Traffic Safety Information Management Complex System by the KOTSA. The simulation scenarios were developed from actual roads by replicating road geometrics and traffic control devices located in Jungnang-gu, Seoul, South Korea.

Variables and Measurements

The main exposures for comparison between the two groups were demographics, driving behaviors, health behaviors, morbidities, and CADReS and driving simulation outcomes. Driving behaviors included driving career, driving frequency, driving time, mileage driven, night driving, parking methods, driving speed, driving capacity, road traffic incidences, traffic tickets, and difficulties in specific situations. Health behaviors included smoking, alcohol consumption, exercise, insomnia, and sleep apnea. Morbidities included hypertension; diabetes; and ophthalmic, ear, joint, and heart disorders.

We performed the CADReS according to the instructions provided in the *Clinician's Guide to Assessing and Counseling Older Drivers*.[3] The survey, including an introduction to the purpose and methods of the tests, required approximately 30 minutes to complete.

Using a vehicle driving simulator, we assessed collisions, velocity (maximum, at the junction), and traffic violations (recognition of pedestrians, obeying the stop line, lane keeping, and obeying traffic signals) in the four scenarios. The participants were previously instructed regarding the use of all operational parts of the driving vehicle (steering, gas and brake pedals, seat belt, rear mirror, and turn signals).

Statistical Analysis

Categorical variables are expressed as frequencies and percentages, while continuous variables are expressed as mean ± standard deviation or as medians and interquartile range (IQR). Chi-square or Fisher exact tests were used for categorical variables and Wilcoxon tests for continuous variables. The AUCs (areas under the receiver operating characteristic [ROC] curves) were calculated to compare the age-related discriminatory power of the assessment tools. DeLong tests were used to compare AUCs.[10] All statistical analyses were performed using SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA). p-values were two sided, with a significance level of 0.05.

Ethics Statement

The Institutional Review Board of Chungbuk National University Hospital reviewed and approved this study (No. CBNUH 2019-10-024-001), and we obtained informed consent from the participants before their participation.

RESULTS

Among 40 participants after excluding four who complained of simulator sickness, 30 (75.0%) were older drivers. The median (IQR) age of the older drivers was 71.5 (68.0–73.25) years, and 27 participants (90.0%) were male. The median (IQR) age of the 10 non-older drivers was 42.0 (25.0–46.75) years, and 3 participants (30.0%) were male. Older drivers with driving experiences of over 20 years comprised 96.7% of this population. Among non-older drivers, 72.8% had driving experiences of less than 20 years. Older drivers were more likely to drive once or twice per week for 1–2 hours per day. However, most driving behaviors did not differ significantly between the two groups (Table 1).

While none of the health behaviors differed significantly between older and non-older drivers, there were clinical differences in terms of the presence of chronic conditions between the two groups. Among older drivers, 20 (66.7%) had hypertension, 7 (23.3%) had diabetes mellitus, 9 (30.0%) had cataracts, 4 (13.3%) had glaucoma, 2 (6.7%) had macular degeneration, 6 (20.0%) had degenerative arthritis, 4 (13.3%) had hearing impairment, and 3 (10.0%) had cardiovascular disease. None of the non-older drivers had these chronic conditions (Table 2).

Table 3 shows the results of the CADReS: 6 older drivers (20.0%) had visual field defects; regarding motor function, older drivers were slower than non-older ones in the rapid walking pace test (8.0 vs. 6.1 seconds; $p < 0.001$); regarding cognitive function, the results of older drivers were worse than those of non-older drivers for the KMoCA (25.0 vs. 28.3; $p = 0.001$), maze test (29.2

Table 1. Comparison of demographics and driving behaviors between older and non-older drivers

Variable	Total (n = 40)	Older driver (n = 30)	Non-older driver (n = 10)	p-value
Age (y)	69.0 (61.0–73.0)	71.5 (68.0–73.3)	42.0 (25.0–46.8)	< 0.001
BMI (kg/m^2)	23.5 (22.0–25.0)	25.0 (22.3–26.0)	22.0 (22.0–22.0)	0.001
Sex, male	30 (75.0)	27 (90.0)	3 (30.0)	0.001
Educational level				0.105
Middle school or below	7 (17.5)	7 (23.3)	0 (0)	
High school	10 (25.0)	7 (23.3)	3 (30.0)	
College or above	23 (57.5)	16 (53.3)	7 (70.0)	
Driving career (y)	35 (22–35)	35 (22–35)	7 (2–18)	< 0.001
Use of seat belts				0.560
Always	37 (92.5)	27 (90.0)	10 (100)	
Not always	3 (7.5)	3 (10.0)	0 (0)	
Driving frequency (day/wk)	3 (1–5)	3 (1–5)	5 (1–7)	0.034
Driving time (hr/day)	1 (1–3)	1 (1–2)	3 (1–3)	0.150
Driving distance (km/day)	25 (9–30)	25 (15–30)	20 (5–30)	0.701
Driving at night (day/wk)	1.5 (1–2)	1.5 (1–2)	2 (1–4)	0.105
Proper parking method to use in driving				0.423
Perpendicular front	6 (15.0)	4 (13.3)	2 (20.0)	
Perpendicular back	23 (57.5)	16 (53.3)	7 (70.0)	
Parallel	2 (5.0)	2 (6.7)	0 (0)	
All	9 (22.5)	8 (26.7)	1 (10.0)	
Driving speed compared with the general flow of traffic				0.254
Faster	6 (15.0)	3 (10.0)	3 (30.0)	
About the same	30 (75.0)	23 (76.7)	7 (70.0)	
Slower	4 (10.0)	4 (13.3)	0 (0)	
Driving capacity				0.333
Excellent	12 (30.0)	9 (30.0)	3 (30.0)	
Good	12 (30.0)	7 (23.3)	5 (50.0)	
Average	15 (37.5)	13 (43.3)	2 (20.0)	
Fair	1 (2.5)	1 (3.3)	0 (0)	
Road traffic incidents in the past year (yes)	6 (15.0)	5 (16.6)	1 (10.0)	0.710
Receiving a traffic ticket in the past year (yes)	13 (32.5)	12 (40.0)	1 (10.0)	0.155
Driving in the rain (yes)	29 (72.5)	23 (76.7)	6 (60.0)	0.498
Difficulty making left-hand turns across oncoming traffic (yes)	17 (42.5)	12 (40.0)	5 (50.0)	0.311
Difficulty driving in rush-hour traffic (yes)	16 (40.0)	12 (40.0)	4 (40.0)	0.655
Difficulty driving on high-traffic roads (yes)	11 (27.5)	8 (26.7)	3 (30.0)	0.732

Values are presented as median (interquartile range) or number of participants (%).
BMI, body mass index.

vs. 18.4 seconds; p = 0.004), and trail-making test (117 vs. 51 seconds; p < 0.001). Four older drivers took longer than 180 seconds to complete the trail-making test (data not shown). However, performance on the clock-drawing test did not differ significantly between the two groups (older 6.6 vs. non-older 7.0; p = 0.166).

Table 4 shows the results of the comparisons of simulation test results between the two groups. In the simulation, while the frequency of crashes and violation rates of the central and stop lines were higher in older drivers than in non-older drivers, the differences were not statistically significant. The rates of right indicator use in the left turn at night and in the right turn at the oblique junction were higher in older drivers than in non-older drivers (p = 0.014 and p = 0.708, respectively). Maximal velocity and velocity at the cross-section were higher in non-older drivers than in older drivers (p < 0.05).

The results of the ROC curve analyses are shown in Table 5. The AUC values for the CADReS and driving simulation outcomes ranged from 0.783 to 0.952, indicating moderate to high assessment accuracy, except for the clock-drawing test (AUC > 0.587).[11] The rapid walking pace test, trail-making test, and velocity of the left

Table 2. Comparison of health behaviors and morbidity between older and non-older drivers

Variable	Total (n = 40)	Older driver (n = 30)	Non-older driver (n = 10)	p-value
Smoking				0.212
Non-smoker	19 (47.5)	13 (43.3)	6 (60.0)	
Ex-smoker	15 (37.5)	13 (43.3)	2 (20.0)	
Smoker	6 (15.0)	4 (13.3)	2 (20.0)	
Alcohol consumption				0.304
Abstinence	6 (15.0)	5 (16.7)	1 (10.0)	
Never	6 (14.6)	6 (20.0)	0 (0)	
Current drinker	28 (70.4)	19 (63.3)	9 (90.0)	
Exercise (physical activity)				0.050
Vigorous intensity	6 (15.0)	4 (13.3)	2 (20.0)	
Moderate intensity	9 (22.5)	9 (30.0)	0 (0)	
Light intensity	25 (62.5)	17 (56.7)	8 (80.0)	
Insomnia	12 (30.0)	8 (26.7)	4 (40.0)	0.451
Sleep apnea	2 (5.0)	2 (6.6)	0 (0)	0.738
Hypertension	20 (50.0)	20 (66.7)	0 (0)	< 0.001
Diabetes mellitus	7 (17.5)	7 (23.3)	0 (0)	0.161
Ophthalmic disorder	13 (32.5)	13 (43.3)	0 (0)	0.016
Ear disorder	5 (12.5)	5 (16.6)	0 (0)	0.307
Joint disorder (degenerative arthritis)	6 (15.0)	6 (20.0)	0 (0)	0.105
Cardiac disorder	6 (15.0)	6 (20.0)	0 (0)	0.016

Values are presented as number of participants (%).

Table 3. Comparison of CADReS outcomes between older and non-older drivers

Variable	Total (n = 40)	Older driver (n = 30)	Non-older driver (n = 10)	p-value
Visual defect, yes	6 (15.0)	6 (20.0)	0 (0)	0.212
Motor function				
Rapid walking pace (s)	7.5 ± 1.6	8.0 ± 1.6	6.1 ± 0.7	< 0.001
Cognitive function				
KMoCA test score	25.9 ± 3.7	25.0 ± 3.4	28.3 ± 1.6	0.001
Maze test (s)	26.4 ± 14.1	29.2 ± 14.9	18.4 ± 7.3	0.004
Trail-making test (s)	100.0 ± 59.2	117.3 ± 59.7	51.4 ± 12.5	< 0.001
Clock-drawing test score	6.7 ± 1.0	6.6 ± 1.1	7.0 ± 0.0	0.166

Values are presented as number of participants (%) or mean±standard deviation.
CADReS, Clinical Assessment of Driver-Related Skills; KMoCA, Korean-Montreal Cognitive Assessment.

turn at the acute junction in the dark showed high discriminatory powers (AUC > 0.9). Table 6 shows the differences in AUCs between the highest assessment accuracy variable, left-turn velocity at night, and other variables. The maze test results showed statistically significant differences (p = 0.044), while the results of the KMoCA (p = 0.051), right turn at an oblique intersection (p = 0.051), and going straight (p = 0.073) approached borderline significance.

DISCUSSION

In this study, we observed that the motor (rapid walking pace) and cognitive (KMoCA, maze test, trail-making test) functions of older drivers were inferior to those of non-older drivers. Older drivers who were tested on four junction scenarios implemented in a vehicle simulator drove slower than non-older drivers. In particular, the simulation of left turns at night showed the highest discriminatory power between older and non-older drivers.

The comparisons of visual sensory, motor, and cognitive functions using the CADReS showed that older drivers were inferior to non-older drivers. Rapid walking pace and trail-making time showed high accuracy (AUC > 0.9) to discriminate motor and cognition functions, respectively, between older and non-older drivers. In the present study, older and non-older drivers required a

Table 4. Comparison of driving simulation outcomes in four junction scenarios between older and non-older drivers

Variable	Total (n = 40)	Older driver (n = 30)	Non-older driver (n = 10)	p-value
Right turn at an oblique junction				
Maximum velocity (km/hr)	-	44.9 ± 11.4	61.4 ± 14.8	0.001
Crash (frequency)	17	13 (50.0)	4 (40.0)	0.717
Use of right indicator (yes)	22	17 (63.0)	5 (50.0)	0.708
Right turn with a pedestrian present				
Velocity at junction (km/hr)	-	14.9 ± 6.0	26.9 ± 10.7	0.001
Recognition of pedestrian	24	19 (79.2)	10 (100)	0.291
Violation of stop line (frequency)	8	6 (24.0)	2 (20.0)	1.000
Left turn at night				
Velocity at junction (km/hr)	-	13.3 ± 7.2	38.0 ± 21.0	< 0.001
Right indicator	32	26 (86.7)	6 (60.0)	0.014
Violation of central line	9	8 (29.6)	1 (10.0)	0.393
Going straight at an oblique junction				
Maximum velocity (km/hr)	-	46.9 ± 11.8	62.2 ± 14.3	0.004
Velocity at junction (km/hr)	-	28.8 ± 19.1	45.2 ± 17.6	0.016

Values are presented as mean±standard deviation or number of participants (%).

Table 5. ROC curve analysis of clinical assessment and driving simulation variables to differentiate distinct age groups

Model	AUC	SE	95% CI	
			Lower	Upper
Rapid walking pace (s)	0.901	0.066	0.771	1.000
KMoCA test score	0.787	0.092	0.608	0.967
Maze test (s)	0.783	0.084	0.619	0.946
Trail-making test (s)	0.928	0.049	0.832	1.000
Clock-drawing test score	0.587	0.106	0.379	0.795
Right turn at an oblique intersection (maximum velocity)	0.816	0.075	0.669	0.964
Right turn with a pedestrian present (velocity at junction)	0.860	0.070	0.723	0.997
Left turn at night (velocity at junction)	0.952	0.034	0.884	1.000
Going straight at an oblique intersection (maximum velocity)	0.807	0.097	0.616	0.998

ROC, receiver operating characteristic; AUC, area under the ROC curve; SE, standard error; CI, confidence interval; KMoCA, Korean-Montreal Cognitive Assessment.

mean of 8.0 and 6.1 seconds, respectively, to complete the rapid walking pace assessments. Older drivers requiring > 9 seconds to complete the rapid pace walking assessment were recommended to consult a physician.[3,12] Other studies reported that rapid walking pace measures > 7 seconds were associated with an increased crash risk among older drivers.[13] The trail-making test, which evaluates cognitive ability related to attention, visual processing, and working memory, was correlated with driving outcomes.[14] Four older drivers in the present study who required > 180 seconds for task completion in this test were recommended to consult a physician.[15]

Vehicle simulators can be used to assess driver capacities such as driving skills and cognition.[4,16,17] These simulators are commonly used in clinical settings because of their high fidelity, safe environment, and reproducibility.[5,18] Driving simulation was reported to be a valid predictor of on-road driving capacity among older drivers.[4] Absolute driver response validity indicates that the same result would be observed between simulation and real life. Even though there were no statistical differences between older and non-older drivers with respect to driving speed and capacity on the self-assessment questionnaire, the driving speed of older drivers was lower than that of non-older drivers during the simulation. As the absolute validity of the vehicle simulator used in this study was not assessed, future studies are warranted to validate the simulator. Another study also reported that older drivers drove at slower speeds in a vehicle simulator, which was related to a lower confidence level in these drivers.[6] However, the vehicle simulator is not an alternative tool to the on-road test but rather is a useful method for assessing driving-related cognitive skills and training regarding on-road driving skills in drivers with cognitive deficits.[19,20]

Age itself may be a risk factor for safe driving as aging reduces driving capacity through decreased cognition and attentional ca-

Table 6. Differences in AUCs between left-turn velocity at night and other variables

Contrast	Difference	SE	95% CI		Pr > ChiSq
			Lower	Upper	
Maze test, left turn at night	-0.167	0.083	-0.330	-0.005	0.044
KMoCA, left turn at night	-0.152	0.078	-0.305	0.001	0.051
Right turn at an oblique intersection, left turn at night	-0.133	0.068	-0.266	0.000	0.051
Traveling straight, left turn at night	-0.159	0.089	-0.332	0.015	0.073
Right turn with a pedestrian present, left turn at night	-0.091	0.061	-0.212	0.029	0.137
Trail-making test, left turn at night	-0.046	0.062	-0.168	0.076	0.463
Rapid walking pace, left turn at night	-0.052	0.075	-0.199	0.095	0.486

AUC, area under the receiver operating characteristic curve; SE, standard error; CI, confidence interval; KMoCA, Korean-Montreal Cognitive Assessment.

pacity.[21] Self-assessment surveys are relatively easy and efficient methods for collecting data regarding violations, errors, and lapses. Driver behavior questionnaires are widely used self-assessment tools to measure aberrant driving behaviors in the field of road safety, in which violation scores are correlated with self-reported accidents and driving speed in a simulator.[22,23] In the present study, the driving behaviors of older drivers did not differ from those of non-older drivers in terms of the subjective questionnaire, despite chronic disorders such as hypertension, diabetes mellitus, cataract, glaucoma, macular degeneration, and arthritis in older drivers.

Our findings of slower speed at cross-sections and worse lane-keeping behavior in older drivers are related to their self-regulating behaviors.[24] The poorer capacity of older drivers makes them avoid problematic driving situations in which they have low confidence. In addition, reduced contrast sensitivity contributed to decreased recognition and capacity, which led to a notable decline in driving speed at night.[25] However, older drivers adapt and behave safely when faced with difficult situations owing to their lengthy driving experiences.[24] Therefore, older drivers' increased use of indicators when turning at junctions may be associated with safe behaviors such as an increase in following distance while driving.

This study had several limitations. First, as in most driving simulation studies, the sample size was too small, which lowered the study power. Moreover, the sizes of the older and non-older driver groups differed substantially, which could explain the non-significant results in the comparisons of the two groups. The low rate of women in the older driver group and the low rate of men in the non-older driver group also hindered the evaluation of driving behaviors of older male and female drivers.

In conclusion, the results of our study showed that motor (rapid walking pace) and cognitive function tests (i.e., KMoCA, maze test, and trail-making tests) in the CADReS, as well as driving simulations using junction scenarios, were good tools to discriminate between older and non-older drivers. A prospective validation study with a larger sample is needed to determine whether these tools can assess the fitness to drive among older drivers potentially at risk.

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CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

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AUTHOR CONTRIBUTION

Conceptualization, SCK; Data curation, SCK, SJH; Funding acquisition, SJH, BHC; Investigation, SCK, SYK; Methodology, SCK, SJH; Project administration, SJH, BHC; Supervision, SJH; Writing–original draft, SCK; Writing–review & editing, SYK, SYU.

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Older Adults' Experiences and Adaptation Strategies during the Midst of COVID-19 Crisis: A Qualitative Instrumental Case Study

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Background: This study aimed to validate one of the propositions of the Need-Threat Internal Resiliency Theory. **Methods:** This study used an instrumental case study of five participants to qualitatively explore older adults' experiences and adapting strategies during the coronavirus disease 2019 (COVID-19) crisis. We selected participants based on parameters and conducted in-depth interviews of 15–30 minutes. The transcribed responses were then analyzed using a phenomenological holistic description. **Results:** Five major themes emerged to explain and describe the various experiences of coping with COVID-19, known as internal resiliency, developed by the older adult participants in response to the perceived threat from this crisis. **Conclusion:** These findings showed that older adult participants had established internal resiliency in response to changes caused by the COVID-19 crisis, resulting in adaptation and coping with the situation, consistent with one proposition of the Need-Threat Internal Resiliency Theory.

Key Words: Aged, COVID-19, Psychological resilience, Qualitative research, Coping behaviors, Philippines

INTRODUCTION

Because of their social vulnerabilities, older persons are among the most affected special population during the coronavirus disease 2019 (COVID-19) pandemic.[1] Moreover, this population has higher risks of acquiring such illnesses owing to their advanced age and the presence of chronic comorbidities.[2] In the Philippines, there were 1,276,004 confirmed cases of COVID-19, with 21,969 deaths, with a high mortality rate disproportionately affecting older Filipinos.[3] This health crisis has a notable disproportionate impact on most marginalized and vulnerable individuals, including older adults.[4] The incidence of diseases, such as hypertension, diabetes mellitus, heart failure, and some respiratory problems, in most older people has greatly affected the prognosis of most patients with COVID-19, especially those aged 60 years and above.[5] Moreover, compared to younger adults, older people affected by this illness have higher numbers of documented cases and risk of developing complications related to COVID-19 owing to the abovementioned factors.[6]

Filipinos in their later years are often strongly religious and hold strong beliefs about God's influence on their health and well-being. Their deep spirituality and faith serve as a source of strength and protection against stress and sorrow.[7] For older adult Filipinos, regularly attending church (masjid for Muslims) services and participating in church events are normal routines in their everyday lives.[7,8] However, the social restriction measures that the society was forced to implement have created imbalances and disrupted the social interaction of older persons within their respective communities.[1] These policy decisions and actions have aggravated the conditions of these older individuals, in turn resulting in poor healthcare access and limited sources for their individual basic needs.[9] Social isolation and disconnection itself poses a serious health concern in this special group considering both psychosocial and physiological aftereffect it may create during such crisis which

includes mental health issues and other at-risk health problems.[10] In fact, multiple studies have shown that this COVID-19 crisis has led to psychological morbidities in older people including but not limited to depression, anxiety, increased level of stress and fear, sleep disturbance resulting to poor sleep quality, accelerated cognitive decline and some physiological problems such as poor cardiovascular and impaired immunity functions while on home or quarantined at healthcare facilities.[2,11]

Social engagement which includes meaningful interactions and connectedness with others is an essential stimulus necessary for older person to improve their physical and mental health as individuals.[1,6] Positive social connections and relationships are considered to be an integral factor for older person's well-being as social beings.[4] Hence, in the presence of this social disequilibrium, older adults are triggered to develop strategies in order to cope with such situation.[1,2] These coping strategies are natural adaptive capacities known as internal resiliency[12] developed by older person in respond to the process of ageing and stressful life experiences such COVID-19 crisis.[1] Coping strategies are essential factors that determine one's well-being in old age.[13] It compensates or alleviates stressful circumstance through reformulation and adjustment to a new and positively assessed environment.[12,13]

The theory on need-threat internal resiliency proposed that in times of crisis, health needs develop into a health threat that compels older persons to develop internal resiliency in order to preserve their integrity, well-being and quality of life as individuals.[12] Internal resiliency refers to the ability to adapt well in the face of adversity, dangers, trauma, or significant sources of stress, collectively known as crisis (e.g., COVID-19 pandemic), to sustain a sense of purpose and vigor, as well as to emerge stronger from such stressful situations.[1,12] In connection, this study aimed to validate one of the assumptions of this theory which states that in times of crisis when threat is perceived, older persons developed a sense of internal control and adaptation to the changes it creates known as internal resiliency,[12] through a qualitative exploration of older person's experiences and coping strategies in the midst of COVID-19 pandemic crisis. Instrumental case studies allow the researchers to utilize the case as a comparison point in different circumstances where the phenomenon may be present while testing established theories.[14]

To produce novel insights and a more detailed understanding of complex realities, diverse lived experiences, and how older people are making sense of and coping with what is happening around them during this crisis, qualitative insights are needed, influencing their resiliency and adaptation to such difficult situations as the COVID-19 pandemic.[15] Moreover, understanding these factors and mechanism that drives older adult's internal resilience during such situations could guide healthcare practitioners including nurses in providing an effective and efficient intervention approaches to such special population who have been greatly affected by this pandemic illness.[6,16]

MATERIALS AND METHODS

Design

A qualitative instrumental case study was adopted to conduct this research. This approach refers to the inquiry of a case (e.g., an individual or specific group) to provide insights regarding a particular issue (such as COVID-19) and the development of internal resiliency in older people owing to the threat it creates among this population.[17] This design allows researchers to use the case as a comparison point in other situations where the phenomenon might be present while developing and testing an established theory.[14]

Participants and Setting

The target population in this study was (1) older adults aged at least 65 years; (2) currently living within the transitory shelters of Barangay Sagonsongan in Marawi City, Philippines during the peak months of the crisis between March and December 2020; and (3) showing any qualities or characteristics of adaptation during the COVID-19 crisis (e.g., calmness or an absence of fear and anxiety owing to the ongoing health crisis). This group of people has been greatly affected by the pandemic crisis in terms of economic and health resources, considering their societal status and as victims of the previous Marawi siege crisis. The Marawi siege, a violent conflict between government forces and pro-ISIS (Islamic State) militants in the city of Marawi, forcibly displaced 98% of the city's inhabitants, including older adults, who were forced to flee owing to severe food shortages and economic constraints.[18] As such, the present study selected these older residents of transitory shelters as target participants based on their experiences in both past and present crises.

Sampling

We applied non-probability sampling using the purposive and snowball approach to identify five participants included in the final analysis. The sample size was determined by data saturation, which occurred when no new themes emerged from the participants' responses following data processing.[17] Purposive sampling uses the judgment of an expert or researcher to identify information-rich cases related to the phenomenon of interest[17] and is widely used in qualitative research such as instrumental case studies.[19]

Instrument & Data Collection

An open-ended guide questionnaire tool was used to collect data during individual in-depth interviews of 15–30 minutes. Some of the questions were as follows: (1) "What is it like to live during the COVID-19 pandemic crisis?" and (2) "What are the challenges you have encountered during the COVID-19 pandemic crisis and what did you do to cope with such circumstances?" A probing question was asked to encourage the participants to provide more details about their experiences. Three qualitative research experts evaluated the guide questionnaire for appropriateness based on the research objectives. We performed a qualitative simulation before actual data collection to identify possible behaviors during the interview process. Rigor in qualitative trustworthiness, including credibility, transferability, dependability, and conformability, was strictly observed.[17] This included confirming with each participant that the detailed description accurately reflected their experiences of coping with the COVID-19 crisis, as well as noting any unclear or misinterpreted themes or discussions, prompting the researchers to amend the relevant descriptions.

Ethical Considerations

We obtained informed consent from all participants and strictly observed health measures regarding COVID-19. The College of Health Sciences of Mindanao State University Ethics Review Committee provided ethics clearance (Approval code: CHS-16-2021) as part of the research protocol included humans. Participants were anonymized by using code names (e.g., P1) during the transcription and analysis of their respective responses. The participants were free to withdraw from the study at any time even after signing the informed consent without any consequences on their part. Participation was voluntary, and no compensation was provided to the participants after the interview.

Analysis

Phenomenological analysis using a holistic description of the bounded phenomenon was adopted to identify themes supporting the study objective.[20] This thematic analysis goes from the original data to the identification of meanings of the participant's verbatim responses, which are then organized into patterns and combined into themes related to the research aim and actual context.[17,21]

RESULTS

Characteristics of the Key Participants

The key informants for this qualitative instrumental case study included five older adult participants comprising four women and one man aged 65–75 years (Table 1). Most participants were widowed and were living in transitory shelters of the Sagonsongan area in Marawi City since COVID-19 began in 2020.

Thematic Analysis

Sixty-two significant statements from the five older adult participants were extracted from the interview transcripts to generate meanings from their verbatim responses. Careful analysis of these statements revealed five main themes and 13 subthemes that explained the experiences and coping strategies of older adults during the COVID-19 crisis. These themes and their corresponding subthemes are summarized in Table 2 and discussed further in the following sections.

Theme 1: Everyday Struggles

This theme included three subthemes, as described below. During a crisis, older adults' constant challenges with their daily lives forced them to adapt and deal with the situation, a process referred to as internal resiliency.

Table 1. Participant profile

Code name	Age (y)	Sex	Civil status
P1	75	Female	Widowed
P2	67	Female	Widowed
P3	72	Female	Widowed
P4	66	Female	Widowed
P5	65	Male	Married

Table 2. Derived themes and subthemes

Theme	Sub-theme
Everyday struggles	Prohibited from going outside and activity limitations
	Insufficient government support
	Lack of income or livelihood
Embracing reality	Acceptance
	Left with no other choices
Cultivating a strong spirituality	Belief in one's fate
	Surrendering self to God and being left without fear
	Strong belief and trust in God
	Considering the situation to be a blessing from God
Finding things to enjoy	Practicing religious rituals and prayers
	Alternative diversional activities to alleviate boredom
Health consciousness	Observing and taking precautions regarding one's health
	Misconceptions regarding COVID-19

COVID-19, coronavirus disease 2019.

Sub-theme 1: Prohibition of going outside and limitation of activities
Most participants reported that the restriction of their normal activities, namely the prohibition of leaving their respective residences, caused them more difficulties than the threat that this virus posed to their health as older adults. These movement restrictions forced the participants to individually adapt and cope with their everyday lives, as indicated by one of the participants' statements:

"When we talk of the way I live right now, I am not having a hard time because of this COVID-19 crisis but because of the protocols in which we are being prohibited to go outside." (P1)

Sub-theme 2: Insufficient government support
The participants indicated that the government provided very little support since the crisis began. Moreover, some of the participants had not received any government assistance during the pandemic crisis. Thus, they were forced to seek alternative sources of living, such as financial help from relatives or neighbors, to survive and cope with the challenges that this crisis imposed on them as older adults. This was supported by the following statement from one of the participants:

"Since they had initiated this strict lockdown policy every Sunday's, we are having a hard time to find ways where we can get our source of living considering that there was no any constant reliefs or aids from the local government." (P2)

Sub-theme 3: Lack of sources of income or livelihood
The participants also described the difficulties they had experienced in surviving this pandemic crisis, not because of the health threats posed by the illness but rather due to the challenges associated with a lack of financial resources. Some participants were still living with their grandchildren who were also responsible for them. Despite these difficulties, the participants were forced to find ways to adapt and cope with the crisis by looking for possible sources of income. This was supported by the following statement from one of the participants:

"What makes it difficult for us now is that no one wants to buy what we sell and we can't also look for another source of living due to this pandemic." (P5)

Theme 2: Embracing Reality
This theme included two subthemes, as described below. When a crisis arises, an older adult embraces reality to adapt to the situation, which is referred to as internal resiliency.

Sub-theme 1: Acceptance
According to older adult participants, such crises have happened before, and the only thing that they can do is recognize their existence in our society. They indicated that they must accept this situation to adapt and continue what they have become used to in life. This was supported by the following statement from one of the participants:

"What is happening now is the same as what happened before which they called measles but all we can do is have patience and to accept the reality because it already happened and came to us." (P4)

Sub-theme 2: Left with no other choices
COVID-19 left most of the participants feeling that they had no choice but to recognize its presence and accept that they must leave it to God and adapt to certain circumstances to live as they had become accustomed. This was supported by the following statement from one of the participants:

"I don't have a choice but to leave this with God, that's the reason I am saying that we are not having a hard time because of this COVID-19 crisis." (P1)

Theme 3: Cultivating a Strong Spirituality
This theme included four subthemes, as described below. To respond to this situation, older adults typically cultivated a deep spirituality during times of hardship (crises), which is referred to as internal resiliency.

Sub-theme 1: Belief in one's fate
Most participants expressed the value and critical need to believe in one's destiny to adapt and deal with the pandemic crisis. Accordingly, they also felt that if God allowed you to become infected, even if you planned to hide, you would become infected and would be unable to avoid the virus. This view was supported by the following participant statement:

"One of the blessings of God for me is that I haven't been to doctor since this pandemic happened because I believe that man was resurrected in this world with fate. This mean that what a person does or is doing is what God will give him. A person can work to get sick if he or she does not avoid them." (P3)

Sub-theme 2: Surrendering self to God and being left with no fear
Most older adults in this study said that they had surrendered themselves to God's will and that what matters was that they were

following and practicing the prescribed preventive measures to avoid being infected with this virus. They said that they felt unafraid, knowing that God would be there to support and help them no matter what challenges the crisis brought to them as individuals. This belief was illustrated by the following participant statement:

"I always come to God when I have a problem and I'm having a hard time. Like the previous days where we had difficulties and problems with livelihood and what I did was I trusted him and reported all these problems during my prayers and a few days later, his help came to my family." (P4)

Sub-theme 3: Strong belief and trust to God

Older adult participants claimed that they worshiped and strengthened their relationship with God while also placing their complete confidence in God during this crisis as they believed that faith and prayers were the only factors to help them forget problems brought about by the current pandemic crisis. Therefore, the participants reported feeling at ease and experiencing a lack of anxiety when going about their daily lives during the crisis. This feeling was supported by the following participant statement:

"God knows that the only thing I am doing is to worship him and I always ask for help from him to exclude me from getting infected from this virus." (P1)

Sub-theme 4: Considering the situation as a blessing from God

The participants reported that trials and crises such as COVID-19 are blessings from God since they teach us to appreciate the little things in life. This was also his way of making them feel and understand that all powers belong to God and that God is the only one who can turn negative situations into positive ones. This view was supported by the following participant statement:

"This is one of the blessings of God (ALLAH swt) for us to know our current standing as of today." (P3)

Theme 4: Finding Things to Enjoy

This theme included two subthemes, as described below. To adjust to unforeseen circumstances, such as crises, older adults are triggered to cope by having something enjoyable to do, which is known as internal resiliency.

Sub-theme 1: Practice of religious rituals and prayers

According to the participants, one of the main coping mechanisms during the pandemic crisis was reading the Qur'an (the holy book for Muslims) and conducting their routine prayers daily. They indicated that these actions provided them strength and protection to prevent COVID-19. Accordingly, they helped the participants to adjust and appreciate things the way they did before the crisis by observing religious rituals and prayers at home. This is supported by the following participant statement:

"What I usually do to cope from this situation is I keep on performing daily prayers and ask God to end this pandemic so that we can go out." (P4)

Sub-theme 2: Alternative diversional activities to alleviate boredom

To address this situation, most of the participants sought alternative diversionary activities, which also made them appreciate the simple activities in which they had participated before the pandemic, resulting in adaptation to the ongoing crisis, such as gardening in their small backyards, watching television with their loved ones, and having a brief talk with their neighbors. This was supported by the following participant statement:

"These little flowers we've planted on the sides of our house are the only thing that helps me to get rid of my boredom." (P2)

Theme 5: Health Consciousness

This theme included two subthemes, as described below. During a crisis, older adults tend to be more health-conscious, particularly when a threat is perceived, which motivates them to cope with the situation, a tendency referred to as internal resiliency.

Sub-theme 1: Observing and taking precautions regarding one's health

As a result of the danger that this illness posed to their health, most older adults admitted to being more health-conscious. They also described having been extremely vigilant in following and putting into practice the recommended health precautions to avoid contracting COVID-19. These shifts in health-seeking attitudes compelled them to respond to the pandemic's continuing crisis. This change was supported by the following participant statement:

"What I did was I continued to avoid the prohibitions in my illness so I was also kept away from the need for a doctor's help. I continued to avoid do and don'ts in my illness. I have been very careful." (P3)

Sub-theme 2: Misconceptions regarding COVID-19

Most study participants acknowledged having certain misconceptions about the current health crisis. These misunderstandings re-

sulted from a variety of factors, including hearsay and a lack of information about the disease. Owing to their uncertainty regarding the virus, the participants become more health-conscious, especially in terms of following health precautions to avoid being infected, which required them to adapt or cope with the current pandemic crisis. This change was supported by the following participant statement:

"I am still undecided whether I will give my consent to be vaccinated in case there's this vaccine to be allotted for the whole community due to the different issues and hearsays existing about this vaccine." (P2)

DISCUSSION

This study tested one of the assumptions of Need-Threat Internal Resiliency Theory, which states that when a threat is perceived in times of crisis, older persons develop a sense of internal control and adapt to changes caused by the crisis, known as internal resiliency. We identified five key themes, each of which illustrated and described the different internal regulations and adaptations that evolved to adapt or cope with the ongoing pandemic crisis, as proposed by the Need-Threat Internal Resiliency Theory.

The first theme, everyday struggles, explains how, during the COVID-19 crisis, challenges with their daily lives forced older adults to adapt and deal with their situations, a response referred to as internal resiliency. As we face the COVID-19 crisis, older adults are among the most vulnerable populations because the pandemic has severely tested their resources and capacities for adaptation and resilience.[22] The individual coping strategies in this population are significantly affected by financial problems.[23] These events may be attributed to the imposition of community quarantines and lockdowns in most areas, in which public and private establishments, including businesses, public transit, workplaces, and other essential operations, were halted for months, causing vulnerable communities (e.g., older adults and people living in poverty) to struggle in terms of day-to-day survival.[23,24] These preventive community strategies have made it impossible for older persons to leave their homes, even to obtain basic necessities, without making other arrangements for food and social security. Furthermore, in most cases, as was the case for the participants in this study, community outreach programs were disrupted, adding to the structural alienation of older adults during the pandemic. The findings of this study, in which most of the older adult participants expressed financial insecurity and a lack of income, were consistent with Li and Mutchler[24] prediction that the financial resources of the older population would be severely impacted due to the COVID-19 crisis.

The second theme, embracing reality, described how, during the COVID-19 pandemic, older adults created a sense of internal resiliency by embracing reality to adapt or cope with the current crisis. Religion, spirituality, and belief systems have always played a variety of roles in the daily lives of older adults, including providing strength, hope, and comfort in challenging situations, such as the COVID-19 crisis.[25] With age, these beliefs become even more important as they serve as a foundational source of strength for achieving positive health outcomes and fostering coping mechanisms, particularly in times of adversity owing to various life crises.[26] These aspects are critical and unique features of resilience in the older population as they are effective coping mechanisms that allow them to adjust to their evolving needs.[27] The participants' descriptions of how they have recognized the COVID-19 crisis as having been planned by God and that the only way for them to adapt or cope with it is to embrace its reality is consistent with the findings reported by Manning,[26] wherein the participants stated that religion, spirituality, and belief systems helped them adapt and develop resiliency in challenging times, including the COVID-19 crisis.[27]

The third theme, cultivating a strong spirituality, explains how, during the COVID-19 crisis, older adults usually cultivate a deep spirituality to respond to such situations, which is referred to as internal resiliency developed by such population groups to adapt or cope with these circumstances. Spirituality is a collection of values that adds vitality and value to people's lives by guiding them to find meaning and intent of their lives, as well as providing hope, compassion, inner peace, comfort, and support.[28] Accordingly, high spirituality levels during times of hardship owing to a crisis can lead to peace of mind and calmness, which can influence an individual's quality of life and resilience, particularly in older adults.[29] Spirituality has the greatest impact on older adults' everyday lives because it offers a structure that guides them through life struggles, allowing them to separate the positive from the negative.[26] This result is reinforced by the findings of a Brazilian study, which concluded that religiosity and spirituality among long-living older adults were important mechanisms of resilience that helped them cope with pathologies, depression, and other significant demands, such as pandemic crises, which reduce their individual well-being and quality of life.[30]

The fourth theme, finding things to enjoy, describes how, during the COVID-19 crisis, the older adult participants in this study were prompted to engage in enjoyable activities, referred to as internal resiliency, to better adapt and cope with their situations. The vulnerability to the COVID-19 crisis, which has resulted in social isolation, has greatly increased the likelihood of certain psychoso-

cial health problems in this group.[16] Religious and spiritual activities during times of crisis are important for assisting individuals, especially older persons, to adapt and cope with such situations.[31] The results of this study are consistent with those of Lucchetti et al.[27] who found that three out of four older adults recognized how religious and spiritual activities (e.g., prayers, reading holy books) have improved the ability of these individuals to cope with the current crisis, especially in terms of their mental and social well-being. Moreover, the participants in this study engaged in recreational activities such as gardening in their small backyards and watching television with their family members to distract themselves. These activities provided them time to do things they would not normally do and taught them to appreciate small things, which has helped ease their concerns and feelings of uncertainty, as well as adjust to their circumstances. This may also explain why the older adults in this study built a sense of internal control and adaptation in response to the perceived threat of this crisis as physical activity in older age is closely linked to higher resilience and the absence or fewer psychosocial issues in times of crisis.[32] The final theme, health consciousness, describes how older adults became more health-conscious during the COVID-19 crisis, particularly when danger was perceived, which motivated them to cope with the situation. This internal resiliency in response to the circumstances allowed them to maintain their individual well-being, integrity, and quality of life. During the COVID-19 pandemic, public activities were suspended in many locations, including recreational facilities, senior daycare centers, and places of worship, to minimize the risk of virus transmission within the population.[33] This proactive strategy negatively affected the everyday lives of older people, making it difficult for them to adapt to new situations,[33,34] as demonstrated by the study participants. The participants in our study strictly followed preventive measures to minimize COVID-19 exposure, such as proper handwashing, social distancing, and wearing a mask and face shield. They used these behaviors as coping mechanisms to protect themselves, their family members, and others. As expressed by the participants, such practices helped them manage stress, limit their fears of infection, and keep busy during the pandemic, allowing them to adapt and live normally throughout the crisis. This finding is consistent with that reported by Finlay et al.[15] who found that older adults often used and identified coping strategies to be resilient amidst the COVID-19 crisis, including changing habits, following public health recommendations, and avoiding health-restricting behaviors (e.g., overeating), all of which encouraged them to have positive adjustments as individuals. Furthermore, Igarashi et al.[34] reported increased self-awareness as a coping mechanism that was unique to older adults.

Conclusion

Resiliency is a common concept that is underestimated among older populations due to a variety of factors, including aging, sexism, vulnerability, and discrimination. The results of this study provide valuable lessons on coping and resilience strategies among older adults during crises; these strategies included (1) everyday struggles, (2) embracing reality, (3) cultivating a strong spirituality, (4) finding things to enjoy, and (5) health consciousness to adapt or cope in their daily battles against difficult and demanding circumstances. The sources of internal resilience identified in this study may have practical implications for promoting the well-being, integrity, and quality of life of older people during the current pandemic and future societal crises. Moreover, health professionals, particularly nurses on the front lines, must recognize and understand the complex needs of older people and tailor their care to support their patients' ability to adapt and cope well in these circumstances. By being aware of their coping strengths as a population group, nurses may be able to identify older adults at risk of being unable to respond to a crisis. This knowledge is essential for bolstering coping strategies that foster internal control and adaptation, also known as internal resiliency, while also considering the personal interests, autonomy, and capabilities of older adults during any crisis. In addition, policymakers, healthcare providers, communities, gerontology experts, and advocates should work together to help this marginalized group by developing and strengthening infrastructures and programs that assist them in connecting to critical resources and services when they are in need, such as in the case of a pandemic crisis, to easily adapt and cope with these situations. In summary, the older adult participants in this study established certain internal resiliency in response to the changes caused by the COVID-19 crisis, resulting in adaptation and coping with the situation, as proposed by the Need-Threat Internal Resiliency Theory.

Limitations

To date, no other studies have assessed older persons' experiences, coping strategies, and resilience in the context of Filipino culture during the COVID-19 pandemic. Thus, this study contributes to the advancement of literature on the Filipino older population during this crisis. However, this study included only five participants and was undertaken in a specific setting (transitory shelters) with identified pre-criteria parameters; therefore, older adults in other areas or communities may have had different experiences and used different coping strategies during the COVID-19 crisis. Future research should apply both qualitative and quantitative approaches to investigate the presence of internal resilience within this population during a crisis (e.g., COVID-19) in a more repre-

sentative sample.

Implications for Practice

- Resilience, as experienced by the older adult participants in this study, does not imply that a person will not face difficulty or distress during a crisis; indeed, the path to resilience will almost certainly include significant challenges in most aspects of their lives, including their physiological, sociocultural, psychological, developmental, and spiritual well-being.
- Spiritual well-being is important for crisis adaptation and coping in older persons as it can lead to a better quality of life at such times.
- In times of crisis (e.g., the COVID-19 pandemic), providers of direct care to older people, such as nurses, doctors, and other allied healthcare professionals, must always consider the individual's overall well-being when providing care and assistance as it can promote resilience.
- Understanding and recognizing the holistic requirements of older people in times of crisis could help nurses and other healthcare providers to tailor their care to support the ability of their patients to adapt and cope with difficult circumstances.
- The sources of internal resilience and coping strategies of older adult participants in this study could have practical implications in promoting the well-being, integrity, and quality of life of this population, particularly during pandemics and community crises. This further suggests that legislators, community members, healthcare professionals, and advocates involved in the care of the older population should devise and implement community initiatives that support older people's positive coping methods to increase their individual resiliency.

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CONFLICT OF INTEREST

The researchers claim no conflicts of interest.

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AUTHOR CONTRIBUTIONS

Conceptualization, JMS; Data curation, JMS, DRP, WS; Investigation, JMS; Methodology, JMS, DRP; Project administration, JMS; Supervision, JMS; Writing-original draft, JMS; Writing-review & editing, JMS, DRP, WS.

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Translation, Cross-cultural Adaptation, and Psychometric Properties of the Turkish Version of the Self-care Ability Scale for the Elderly

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Purpose: The Self-care Ability Scale for the Elderly (SASE) is a frequently used scale that was created in Sweden according to Orem's self-care deficit theory and later modified according to Pörn's theory of environment and purpose. This study translated and cross-culturally adapted the Turkish version of the SASE (T-SASE) and demonstrated its psychometric properties, including its reliability and construct validity. **Methods:** This study recruited a total of 122 participants and applied international guidelines for the translation and adaptation of the scale. The test-retest reliability of the SASE was calculated at 1-week intervals. Internal consistency was analyzed using Cronbach's alpha. For construct validity, we compared the T-SASE to the Nottingham Extended Activities of Daily Living Scale (NEADLS) and the Exercise of Self-Care Agency Scale (ESCAS). **Results:** The mean age of the participants was 68.6±5.7 years. The test-retest reliability of the T-SASE was excellent (intraclass correlation coefficient=0.914; 95% confidence interval, 0.81–0.95). The internal consistency of the total T-SASE score was also excellent (Cronbach's α=0.912), as were the Cronbach's alpha scores for the individual items, ranging from 0.901 to 0.915. The items were also highly consistent with each other (Cronbach's α>0.80). The construct validity of the T-SASE was acceptable (0.35<r<0.50) in a convergent manner. The T-SASE was also strongly correlated with the NEADLS and ESCAS (r_1=0.405, r_2=0.437, p<0.01). **Conclusions:** The T-SASE was a reliable and valid tool for assessing the self-care ability of community-dwelling older adults. Owing to its multidimensional structure, the T-SASE is an essential tool for evaluating self-care in older adults.

Key Words: Psychometrics, Self-Care, Aptitude, Surveys and Questionnaires

INTRODUCTION

The United Nations estimated that the number of people aged 60 and over will exceed 2 billion in 30 years. Therefore, evaluating self-care in this older population is of particular importance.[1] The aging process includes a decrease in the functional level as well as physiological deficiencies. In the process of aging, some restrictions occur in daily living activities.[2,3] Self-care ability is an essential determinant of the maintenance of daily life activities in older adults.[4] Self-care is defined as personal care initiated by individuals on their behalf to maintain their health and well-being, while self-care ability is defined as the ability to perform self-care or self-management activities.[5] Self-care in older adults encompasses both self-care ability and process. Self-care ability includes self-care activities to identify individual needs, evaluate internal and external resources, and provide functional independence.[6] Self-care ability is performed under certain environmental conditions and using various devices for a specific purpose. Personal care activities (e.g., nutrition, dressing, and body cleaning), home cleaning, transportation, and shopping are generally performed by a device.[4] Person-

al care activities can be affected by many conditions, such as health, good habits, self-esteem, and self-care ability.[7] However, advanced age negatively affects self-care,[8] while the ability to perform daily life activities and level of education positively affect self-care.[9,10] A person's self-care ability may differ in different developmental stages and in acute or chronic health conditions.[7] Self-care ability is an essential source of health in older adults, especially those living in their own homes,[6] and also enables older people with self-care ability to manage their existing diseases and develop their behaviors.[11] Increasing self-care ability may support disease prevention and healing and improving individuals' quality of life.[12,13]

Health professionals should be encouraged to improve the self-care ability of older adults, which requires evaluation of this ability of older adults at individual and social risk and the development of treatment plans.[14,15] Various tools for assessing self-care have been described in the literature. Tools used for older adults[16] include the Self-care of Home-Dwelling Elderly Instrument, Lorensen's Self-Care Capability Scale, and the Self-care Ability Scale for the Elderly (SASE).[17-19] The Self-care of Home-Dwelling Elderly Instrument and Lorensen's Self-Care Capability Scale contain 82 and 56 questions, respectively, which impose a burden to complete.[17,18] In contrast, the SASE has relatively fewer questions and is widely used for clinical evaluation.[20]

The SASE was created in Sweden according to the Self-Care Deficit Theory and later modified according to Pörn's theory of environment and purpose.[4,14] The SASE originally contained 53 items, which was reduced to 17. The Cronbach's alpha coefficients ranged from 0.44 to 0.88 for the five factors of the SASE and between 0.70 and 0.80 for three factors.[20] In their systematic review, Matarese et al.[16] found strong evidence of SASE content validity and moderate evidence of construct validity and hypothesis testing. However, they cited contradictory evidence regarding the internal consistency of the SASE. The items in the SASE measure the ability of older individuals to perform daily life activities, their health and life satisfaction experiences, and their purpose in performing some daily life activities.[20] The validity and reliability of the Swedish version of the SASE have been reported.[4,20] The SASE was later translated into Chinese,[21] Norwegian,[22] Italian,[23] and Iranian[24] languages, and its psychometric properties were examined. However, to our knowledge, the validity and reliability of a Turkish version have not been established. The psychometric study of the Turkish version of SASE can be used in clinical studies to evaluate the self-care skills of Turkish-speaking healthy older individuals. In addition, it would be a preferable scale for evaluating geriatric rehabilitation programs in clinical training provided to older adults.

This study aimed to translate the SASE into Turkish, adapt it culturally, and test its reliability and validity in healthy older individuals.

MATERIALS AND METHODS

Translation and Adaptation Process

To examine the psychometric properties of the SASE, permission to use the scale was obtained from Ulrika Söderhamn who developed it.[20] The scale's cultural adaptation was carried out according to internationally accepted translation procedures.[25] In the first stage, the advanced translation stage, the original Swedish version of the SASE was translated into Turkish independently by two professional bilingual translators whose native language was Turkish and who were also proficient in Swedish. Expert committee members (two academician physiotherapists) identified and recorded problems related to culture and linguistics. In the second stage, the same expert committee discussed the correction notes for these translations. At this stage, the third item was modified. The committee added the term "dentures, if any" to the end of the sentence with parenthesis. Additionally, the word "house-keeping" mentioned in the 4th and 13th items is used more frequently in European countries, while "house cleaning" is more commonly used in Turkish. Therefore, we used the term "ev temizliği" ("house cleaning") instead of "house-keeping." In the third stage, the SASE was translated into Swedish independently by two translators whose mother tongue was Swedish. The original Swedish SASE was compared to the back-translated version. In the fourth stage, conceptual and linguistic issues were discussed. In the fifth stage, a draft version was produced for use in pilot testing. In the last stage, a pilot study was conducted to determine whether the Turkish version of the SASE provided suitable understandability. A pre-test was conducted on a 5-point Likert-type scale with 30 older adults speaking Turkish. The understandability was excellent in this pilot study. Therefore, no additional changes were made. Finally, the Turkish version of SASE (T-SASE) was created.

Ethical Statement

The permission for the translation for the Turkish version of the Self-care Ability Scale was acquired from the developer of the original questionnaire. The study was carried out in accordance with the ethical principles and the Helsinki Declaration. Informed consent of the patients was obtained. The study protocol was approved by the ethics committee of Ege University (No. 21-3T/22).

Sample Size Estimation

Terwee et al.[26] recommended at least 100 patients for the assessment of the internal consistency of health-related patient-reported

outcome measures (PROMs). In addition, the required sample size to analyze the T-SASE reproducibility was calculated using the G*Power 3.1 software with an effect size of 0.50, a probability of error of 0.05, and a power of 0.80.[27] The effect size for test-retest reliability analysis (i.e., reproducibility) was determined using Cohen's d coefficient (0.50), which indicates a medium-sized standardized difference between test and retest.[28] In conclusion, at least 21 patients were required for the reliability analysis. Thus, 30 patients repeated the T-SASE 1 week after the initial assessment.

Study Design

This prospective cross-sectional study conducted by the Department of Geriatrics at Ege University included healthy older individuals. The following older individuals were included in this study: (1) older individuals aged 65 years and older and (2) those who could read, understand, and speak Turkish. Older individuals (1) with acute or chronic diseases that could affect their self-care, (2) those who were bedridden, or (3) those who did not agree to participate in the study were excluded.

The sociodemographic and physical characteristics of the older individuals participating in the study were collected. The Turkish versions of the Nottingham Extended Activities of Daily Living Scale (NEADLS)[29] and the Exercise of Self-Care Agency Scale (ESCAS)[30] were performed as a parallel form to assess SASE's structural validity. In the first evaluation, 122 older individuals answered all the items of the T-SASE, NEADLS, and ESCAS in the given order. The retest evaluation of the T-SASE was conducted 1 week later with 30 older individuals.

SASE

The SASE is a self-report tool developed by Söderhamn to measure self-care ability in older individuals. The SASE consists of 17 items related to daily life activities, well-being, mastery, willpower, determination, loneliness, and dressing. Each item's score ranges from 1 to 5 (1 "completely disagree" to 5 "completely agree"). Three points were considered neutral scores. Items containing negative statements are summed by reversing the score. The total score ranged from 17 to 85, with higher scores indicating increased self-care ability.[4]

NEADLS

The NEADLS was developed to evaluate daily living activities in rehabilitation centers in England.[31] The NEADLS consists of four subsections containing questions about mobility (six items), kitchen (five items), housework (five items), and leisure activities (six items). The answers to all questions are evaluated as follows: 0 points, never done; 1 point, can be done with help; 2 points, can be done by force; and 3 points, can be done quickly without assistance. A final score ranging from 0 to 66 points was obtained by summing the scores from each subsection. This scale can also be conducted through clinician interview or by mail.[29]

ESCAS

The scale, consisting of 35 items, was intended to determine individuals' self-care abilities. The scale is evaluated using a 5-point Likert scale (0 = does not describe me at all, 1 = does not describe me much, 2 = I have no idea, 3 = describes me a little, 4 = describes me very well). Items #3, #6, #9, #13, #19, #22, #26, and #31 on the scale have negative meanings and are evaluated as negative. The highest possible score on the ESCAS is 172.[30]

Statistical Analysis

All data collected from the research were analyzed using IBM SPSS for Windows version 25.0 (IBM Corp., Armonk, NY, USA). Means and standard deviations were calculated for quantitative data and percentages for qualitative data. Shapiro-Wilk tests were used to test the data for a homogeneous distribution. The minimum and maximum T-SASE scores were also analyzed for possible floor or ceiling effects. In addition, 95% confidence intervals (CIs) were used to calculate the correlation coefficients. Internal consistency was analyzed by calculating the Cronbach's alpha of the total score and all items of the T-SASE, with alpha values above 0.6 and 0.8 representing good and excellent internal consistency, respectively.[32] For test-retest reliability, the intraclass correlation coefficient (ICC) was calculated for the total T-SASE score, with an ICC value over 0.8 indicating perfect reproducibility.[33] The construct validity of the T-SASE was analyzed by correlation with the NEADLS and ESCAS based on Pearson correlation coefficient (r). The coefficient was considered high for values above 0.5, moderate for values between 0.5 and 0.35, and low for values below 0.35.[34]

RESULTS

The mean age of the older adults was 68.6 ± 5.7 years. This study included a total of 84 women (68.9%) and 38 men (31.1%). A larger number of the participants had a bachelor's or higher degree. More than half of the participants were married and lived with their families (59% and 64.8%, respectively). Most of the older adults were able to walk independently without an assistive device (95.9%). Similarly, most participants did not have a fall history (75.4%). The participant characteristics are presented in Table 1. The absolute values of the PROM measurements of older adults are presented in Table 2.

Table 1. Patients' characteristics (n=122)

	Value
Age (y)	68.6 ± 5.7
BMI (kg/m^2)	26.7 ± 4.0
Sex	
Female	84 (68.9)
Male	38 (31.1)
Education	
Primary school	29 (23.8)
Middle school	7 (5.7)
High school	13 (10.7)
University or higher degree	73 (59.8)
Marital status	
Married	72 (59.0)
Single	50 (41.0)
Residence	
Family	79 (64.8)
Alone	37 (30.3)
Other	6 (4.9)
Chronic diseases	
Yes	69 (56.6)
No	53 (43.4)

Values are presented as mean±standard deviation or number (%).
BMI, body mass index.

The test-retest reliability of the T-SASE was excellent (ICC = 0.914; 95% CI, 0.81–0.95). In addition, the internal consistency of the total T-SASE score was excellent (Cronbach's α = 0.912). The Cronbach's alpha scores for the individual items were also excellent, ranging from 0.901 to 0.915 and the items were highly consistent with each other (Cronbach's α > 0.80) (Table 3). The construct validity of the T-SASE was acceptable (0.35 < r < 0.50) in a convergent manner. The T-SASE was strongly correlated with the NEADLS and ESCAS (r_1 = 0.405, r_2 = 0.437, p < 0.01) (Table 4).

DISCUSSION

The present study aimed to develop and cross-culturally adapt a Turkish version of the SASE. We also aimed to demonstrate the reliability and validity of the T-SASE. Considering the importance of standardized and adapted PROMs in geriatric occupational therapy, the T-SASE is an essential tool for evaluating the self-care ability in older adults in performing activities of daily living and to identify individual care issues.[14,20] Our results showed that the T-SASE was a reliable and valid scale for use in community-dwelling older adults. The internal consistency and test-retest reliability of the T-SASE were high, and the validity was acceptable in the construct validity analysis in terms of convergent substance.

Table 2. Absolute values of the patient-reported outcome measures (n=122)

	Value
T-SASE	71.43 ± 8.49 (29–80)
NEADLS	61.06 ± 6.45 (32–66)
ESCAS	122.09 ± 14.22 (69–140)

Values are presented as mean±standard deviation (range).
T-SASE, Turkish version of the Self-care Ability Scale; NEADLS, Nottingham Extended Activities of Daily Living Scale; ESCAS, Exercise of Self-Care Agency Scale.

Table 3. Test-retest reliability and internal consistency of the T-SASE (n=30)

Item#	Test	Retest	Cronbach's α
1	4.33 ± 1.04	4.16 ± 1.11	0.907
2	4.71 ± 0.70	4.83 ± 0.37	0.901
3	4.75 ± 0.69	4.80 ± 0.40	0.903
4	4.63 ± 0.81	4.36 ± 0.80	0.903
5	4.71 ± 0.68	4.66 ± 0.47	0.901
6	4.31 ± 0.61	3.40 ± 1.21	0.913
7	4.20 ± 0.97	4.06 ± 0.78	0.910
8	4.45 ± 0.83	4.40 ± 0.49	0.905
9	4.36 ± 0.86	4.26 ± 0.58	0.903
10	4.24 ± 0.91	4.36 ± 0.71	0.905
11	4.54 ± 0.80	4.26 ± 0.94	0.903
12	4.22 ± 1.12	4.36 ± 0.71	0.913
13	4.39 ± 0.96	4.23 ± 1.04	0.904
14	4.20 ± 0.60	3.20 ± 1.06	0.915
15	4.39 ± 0.74	4.36 ± 0.66	0.905
16	4.40 ± 0.63	4.16 ± 0.74	0.911
17	4.74 ± 0.76	4.83 ± 0.37	0.906
T-SASE	71.43 ± 8.49	72.53 ± 5.07	0.912

Values are presented as mean±standard deviation.
T-SASE, Turkish version of the Self-care Ability Scale.

Table 4. Correlations between the NEADLS and ESCAS with T-SASE (n=122)

	r	p-value
T-SASE – NEADLS	0.405	< 0.01
T-SASE – ESCAS	0.437	< 0.01

r, Pearson correlation coefficient; T-SASE, Turkish version of the Self-care Ability Scale; NEADLS, Nottingham Extended Activities of Daily Living Scale; ESCAS, Exercise of Self-Care Agency Scale.

In terms of self-care, the independence of older adults is essential and is primarily related to their quality and adeptness of life. Developed by considering Pörn's health and adaptation theory, the SASE is widely used to measure the self-care capacity of older adults in a standardized, practical, and accurate manner.[4,14,20] However, it may not be sufficient to express only functional ability in evaluating

self-care ability, and independence in daily living activities is adequate. This assessment must include both cognitive and emotional components. Unlike the current tools to assess activities of daily living and self-care, the T-SASE provides a more specific self-care assessment, including these parameters, especially in older adults, who often have cognitive and depressive problems.[20)]

The original Swedish version of the SASE has been translated to Chinese, Italian, Norwegian, and Persian.[20-24)] The culturally adapted versions are reliable, valid, and frequently used tools to assess self-care ability in older adults. Our study translated and adapted the SASE into Turkish according to internationally accepted guidelines.[25)] During this process, only one modification was carried out for item #3, which assesses oral hygiene, in which the term "varsa diş protezi" is given in parentheses. We put the word "dentures, if any" before this expression in Turkish to preserve the grammatical structure of the questionnaire.

The reliability of the T-SASE was assessed by analyzing its internal consistency and test-retest reliability. The internal consistencies of the total score and the items of T-SASE were excellent (> 0.80). The SASE comprises items related to the functional, cognitive, and emotional components of self-care ability. This versatile tool's capacity to evaluate self-care activities holistically and consistently is essential for its reliability.[4)] Thus, we analyzed the internal consistency of the total score and the items' independent alpha scores and found that the T-SASE evaluated older individuals consistently. The items of the scale were also consistent with each other to assess self-care in a three-dimensional manner. The original Swedish version showed Cronbach's alpha values of 0.68 and 0.88 in older patients and community-dwelling older adults, respectively.[20)] The Cronbach's alpha value for the Italian version ranged from 0.72 to 0.90,[23)] while the values for the Chinese, Norwegian, and Persian versions were 0.89, 0.85, and 0.73, respectively.[21,22,24)] The results demonstrated the acceptable to high consistency of the SASE in all cultures, including Turkey. Thus, this tool provides clinicians and researchers consistent assessment of the self-care ability of patients and older individuals.

The generally accepted retest time intervals reported in the literature range between 2 days and 2 weeks.[26)] The test-retest reliability of the T-SASE total score was excellent (> 0.80); in other words, the T-SASE showed acceptable reproducibility. The T-SASE showed accurate results for measurements performed at different times. T-SASE provided the participants' actual score without bias and evaluation error.[33)] The Chinese and the Italian versions showed ICC values of 0.99 and 0.92, respectively,[21)] while those of the Persian version ranged from 0.85 to 0.97.[24)] The original development study did not calculate ICC values.[20)] These findings demonstrate the reliability of the SASE in terms of reproducibility. The results of the Turkish version are similar to those of the other versions.

Construct validity is another essential component for revealing PROM psychometrics. Factor analysis or convergent-divergent validity by comparing to other standard tools are used for scale validation.[34)] The present study focused on convergent validity, considering the structure of the SASE. Because similar tools that evaluate daily living activities focus only on functionality, we compared the SASE to the NEADLS. The primary goal was to evaluate the appropriateness of the self-care activities by multidimensional evaluation by comparing the T-SASE to a one-dimensional tool (NEADLS).[29)] In addition, we examined the ability of the questioning self-care agency of SASE by comparing its concordance to a gold standard questionnaire (ESCAS).[30)] The NEADLS does not comprehensively examine the health and life satisfaction of older individuals in terms of self-care.[29)] The ESCAS, on the other hand, has a long structure, containing 35 items.[30)] Therefore, the T-SASE may provide advantages over both questionnaires. Our validity results showed that the T-SASE was strongly correlated with the NEADLS and ESCAS ($r_1 = 0.405$, $r_2 = 0.437$, $p < 0.01$). Based on the commonly applied reference cut-off values for construct validity ($0.35 < r < 0.50$), the T-SASE showed acceptable validity.[34)] None of the version studies and the original validation study reported the convergent validity with comparisons to other questionnaires. The Italian version compared the SASE to the Katz Index of Independence in Activities of Daily Living and the Lawton Instrumental Activities of Daily Living, in which the correlation coefficients ranged from 0.11 to 0.63.[23)] Instead of the Katz and Lawton questionnaires, we compared the T-SASE to the NEADLS, the items of which were more consistent with those of the SASE. Both the Italian and Turkish versions of the SASE also showed acceptable validity.

This study had several limitations, which could inform the design of future SASE validation studies. First, confirmatory and explanatory factor analysis could be used to comprehensibly express the construct structure in assessing the SASE validity. However, as other versions adequately provided these analyses,[21,24)] we focused more on convergent validity. Second, while this study recruited community-dwelling older adults, additional studies are needed to evaluate clinical populations and hospitalized older patients to demonstrate the psychometrics of SASE in detail. Third, the present and other versions have not evaluated the responsiveness of the SASE. Determining the relationships between clinical and other endpoints, as well as variations in SASE scores over time, will be essential. Finally, retest evaluations should be conducted at least 2 weeks later to avoid potential practice effects.

In conclusion, the results of this study showed that the T-SASE

was a valid and reliable tool for assessing the self-care ability of community-dwelling older adults. Owing to its multidimensional structure (functionality, cognitive, and emotional), the SASE is an essential tool for geriatric rehabilitation specialists to evaluate daily living activities and daily self-care issues in older adults.

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CONFLICT OF INTEREST

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Conceptualization, FO, MO, SS; Data curation, MO, SS; Investigation, FO, MO, SS; Methodology, FO, MO; Project administration, FO, MO, SS; Supervision, FO, MO, SS; Writing-original draft, FO, MO, SS; Writing-review & editing, FO, MO, SS.

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An Unusual Case of Shock in an Octogenarian

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An octogenarian presented to our hospital in shock after being "found down" at home. She was dehydrated, hypernatremic, and suffering from a urinary tract infection. Findings of a murmur and those on electrocardiography led to the performance of echocardiography, with all findings consistent with a diagnosis of hypertrophic obstructive cardiomyopathy. The patient was volume resuscitated and administered antibiotics; after stabilization, she was started on a low-dose beta-blocker. Hypertrophic cardiomyopathy is a common genetic disorder that is usually diagnosed in the second to fifth decades of life, rarely being diagnosed at an advanced age. It is also an uncommon cause or contributor to shock. We briefly review the diagnosis and management of hypertrophic cardiomyopathy in older adults, particularly in the setting of shock.

Key Words: Hypertrophic cardiomyopathy, Aged, Case reports, Shock

INTRODUCTION

The differential diagnosis of patients presenting with shock is broad and includes sepsis, hypovolemia, anaphylaxis, neurogenic compromise, impaired cardiac output from a low ejection fraction, and tamponade, among other causes. Although hypertrophic cardiomyopathy (HCM) is common in the general population, it is an uncommon cause of or contributor to shock. It is also usually diagnosed in younger individuals. The condition is increasingly diagnosed in older patients because of an increased index of suspicion and use of imaging. However, diagnosing an octogenarian with HCM is uncommon and may be a complex endeavor. We report a case of an initial diagnosis of HCM in a patient who presented with shock and review pertinent diagnostic, prognostic, and management considerations.

CASE REPORT

An 84-year-old woman was brought to the emergency department (ED) after being found at home (where she lived independently) by her son with whom she had not had any contact for 4 days. In the ED, she was found to have a heart rate of 103 bpm, blood pressure (BP) of 83/53 mmHg, and oxygen saturation of 96% on ambient air. She had very dry mucous membranes, and a 4/6 systolic murmur was best heard at the base and in her bilateral carotid arteries. Laboratory examinations showed a sodium level of 165 mEq/L, a creatinine level of 5.4 mg/dL, an international normalized ratio (INR) of 3.2, an elevated white blood cell count, and urinalysis findings consistent with an infection (culture grew pan-sensitive *Escherichia coli*). Computed tomography of the head revealed no remarkable findings. Her son reported that she had no medical or surgical history, was not taking medication, and had not seen a healthcare provider in years. He denied her having any "bad habits" or a family history of medical problems. Written informed consent was obtained from the patient for publication of this case report and accompanying images.

The patient received 2 L of lactated Ringer's solution, and antibiotic therapy was initiated. Her BP increased to 107/64 mmHg; her mental status also improved (able to answer yes/no questions), and she was able to follow basic instructions. Because of the murmur observed and the findings on electrocardiography, she underwent echocardiography (Fig. 1). The results of electrocardiography and echocardiography were consistent with a finding of HCM. Specifically, the electrocardiogram (ECG) showed a high voltage

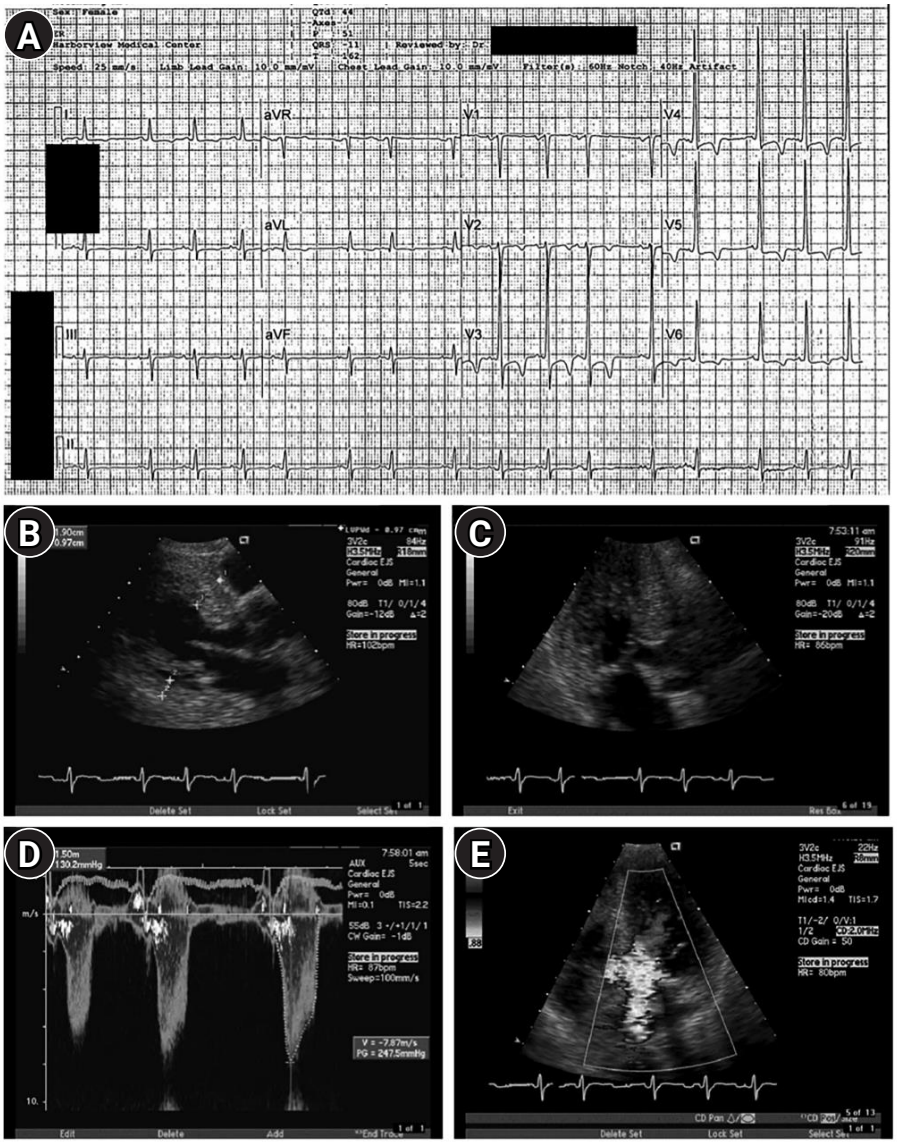

Fig. 1. (A) Electrocardiogram obtained at admission showing a sinus rhythm with premature atrial complexes, as well as voltages and repolarization abnormalities consistent with left ventricular hypertrophy. The remaining panels show findings consistent with hypertrophic obstructive cardiomyopathy, including (B) predominant septal hypertrophy, (C) systolic anterior motion of the mitral valve, (D) a very high left ventricular outflow tract gradient, and (E) moderate mitral regurgitation. Other findings included a normal-sized left ventricle with hyperdynamic function (ejection fraction >70%).

and repolarization abnormalities consistent with left ventricular hypertrophy. The echocardiogram showed severe asymmetric septal predominant hypertrophy (septal wall thickness, 1.9 cm; posterior wall thickness, 0.97 cm), systolic anterior motion of the mitral valve with outflow tract obstruction, severe peak and mean left ventricular outflow tract gradients (248 and 130 mmHg, respectively), and moderate mitral regurgitation.

DISCUSSION

HCM is a common genetic condition affecting at least one in 500 persons.[1] Although the condition affects people of all ages, most patients are diagnosed early in life (mean age, 44 years). HCM is increasingly diagnosed in older adults, likely because of an increasing index of suspicion as well the growing use of imaging, which may uncover the phenotype in patients being evaluated for cardiac and non-cardiac conditions (e.g., during echocardiography, chest computed tomography, or magnetic resonance imaging [MRI]). When diagnosed in older adults, the condition may be late-onset or, because of a lack of symptoms, late to have been recognized.

When an older adult presents with symptoms that may be attributable to HCM, the differential diagnosis is extensive. Dyspnea

on exertion, chest pain, and syncope can have many etiologies or be multifactorial owing to age-related problems, including volume depletion, deconditioning, or comorbidities such as lung conditions (e.g., chronic obstructive pulmonary disease), coronary artery disease, valve disease, arrhythmias, or heart failure. Physical examination may be challenging, as the murmur due to HCM may be confused with or masked by that due to aortic sclerosis or stenosis. These other etiologies may be pursued before cardiac imaging (usually echocardiography). Once imaging raises the possibility of a differential diagnosis of HCM, the diagnosis may remain uncertain as other conditions can have similar morphologic appearances.

Other entities that may be considered include age-related structural changes (discussed below), hypertensive cardiomyopathy, and amyloid or other infiltrative cardiomyopathies (e.g., hemochromatosis). A detailed approach to the diagnosis of these is beyond the scope of this report; however, more global hypertrophy and a history of un/under-treated hypertension and other end-organ damage suggest hypertensive cardiomyopathy and hypertrophy on echocardiography but a low voltage on ECG, whereas other specific findings on imaging or comorbid conditions may point toward amyloid or other infiltrative cardiomyopathy.

A sigmoid-shaped septum (also called discrete upper septal thickening or upper septal knuckle) is found in older adults (particularly those with hypertension) and may result from normal aging. The prevalence is up to 10%, and an increased angle of the aorta to the long axis of the left ventricle (LV) is also common. In the Framingham Heart Study, 1.5% of 3,562 participants had a sigmoid-shaped septum (17.8% of those >85 years). The positive correlates were increasing age, hypertension, decreased LV fraction, and mitral annular calcification, whereas the inverse correlates were the LV diastolic dimension. After adjusting for cardiovascular risk factors, over 15 years, the condition was not found to be associated with cardiovascular events or mortality.[2)]

Differentiating normal aging from genetic HCM is challenging. Patients with late-onset HCM tend to have less impressive septal hypertrophy and an ovoid or ellipsoid (not crescentic) LV.[3)] Other differences include narrower left ventricular outflow tracts (LVOTs), anterior displacement of the mitral valve, and a larger area of septum-anterior leaflet contact.[4)] Chen-Tourneaux et al.[5)] suggested that specific echo-Doppler findings distinguish the sigmoid septum from HCM with a sensitivity of 78% and a specificity of 90%; moreover, cardiac MRI is also increasingly used for evaluation.

Of the 3% of patients in the Framingham Heart Study (n=1,862; mean age, 60 years) with unexplained LV hypertrophy, only 18% had sarcomeric contractile protein mutations.[6)] Another analysis reported that the sites of mutation found in late-onset patients (myosin binding protein-C, troponin I, alpha cardiac myosin heavy chain) differed from those found in younger patients (beta-myosin heavy chain, troponin T, alpha tropomyosin).[7)]

The clinical course of patients diagnosed with HCM at an advanced age is generally better than that of those diagnosed at a younger age.[8,9)] In a study of 428 patients aged ≥60 years followed up for nearly 5 years, the rates of HCM-related morbidity and mortality (including sudden death) were low. Other studies have also shown lower rates of traditional HCM-related risk factors for sudden cardiac death (SCD)[10,11)] but concomitantly higher rates of atherosclerotic cardiovascular risk factors in older cohorts.[12)] Of the 428 patients included in that study, only 16 had HCM-related mortality (0.64% per year).[13)] Death from progressive heart failure occurred in only two patients, embolic stroke in six patients, and SCD in five (1.2% of the population; 0.20% per year). Other reports also reveal that the HCM-related rates of heart failure, embolic stroke, or SCD in patients >60 years of age are lower than those reported at younger ages, with annual mortality rates less than those in age-and sex-matched controls.[13,14)] Notably, the presence of atherosclerotic risk factors, atherosclerosis itself, and other comorbidities in this population contributed to the finding that older HCM patients most frequently die of non-HCM related causes.[13)]

Standard treatment may be considered for older adults diagnosed with HCM, including medical therapy (e.g., beta-blockers, calcium channel blockers, and disopyramide). Medically refractory patients, even those of advanced age, may be evaluated for alcohol septal ablation or surgical septal myectomy.[12)] Family/genetic counseling and testing should be considered, as well as evaluation for primary or secondary prevention ICD (implantable cardioverter-defibrillator) placement and a rhythm control strategy for patients with atrial fibrillation that can affect up to one-third of older HCM patients (antiarrhythmic medications and/or ablation) may be contemplated, although older adults may be at an increased risk for complications.[12,15)] Regarding the management of patients with hypertrophic cardiomyopathy and shock, other etiologies of shock should be evaluated and treated, including infection (sepsis), anemia, and volume depletion. Echocardiography is the fastest route to the diagnosis of HCM and can be useful for evaluating and managing other etiologies of shock; thus, this should be considered early after presentation. Lastly, to avoid worsening LVOT obstruction, both volume depletion and inotropes should be avoided. If vasopressors are required (they were not in the present case), choosing one that is not also an inotrope is advisable.

In conclusion, after correction of the free water deficit and the administration of antibiotics, the patient's laboratory abnormalities

resolved and her mental status returned to baseline. Her shock was likely multifactorial, owing to a combination of dehydration and urinary tract infection, resulting in volume depletion and increased myocardial demand, both of which worsened the LVOT obstruction, further impairing her cardiac output. After stabilization, the patient was started on a low-dose beta-blocker in addition to antibiotics. She and her son declined further evaluation of her HCM (including cardiac MRI, genetic evaluation, and outpatient rhythm monitoring for ventricular arrhythmias/risk stratification for sudden death), and she was discharged to a rehabilitation facility with plans for outpatient follow-up.

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Sporadic Creutzfeldt-Jakob Syndrome Misdiagnosed as Recurrent Stroke: A Case Report

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While sporadic Creutzfeldt-Jakob disease (sCJD) typically presents with neurological symptoms such as cognitive impairment, ataxia, and myoclonus, its clinical manifestations can be diverse. We report a 70-year-old woman with sCJD who was misdiagnosed with recurrent stroke. She initially showed hemiplegia and high-intensity signals on brain diffusion-weighted magnetic resonance imaging (DWI), which corresponded to the symptoms of a stroke. She was diagnosed with recurrent stroke as her muscle weakness showed stepwise deterioration, with the appearance of additional high-intensity signals on brain DWI. Several days later, she developed Broca's aphasia, cognitive impairment, and myoclonus in the right upper and left lower extremities. Brain DWI showed high-intensity signals in the cortex, caudate nucleus, and putamen. Therefore, sCJD was suspected; she subsequently underwent further evaluation and was diagnosed with sCJD. The findings of this case indicate that sCJD can have a clinical course similar to that of recurrent stroke.

Key Words: Creutzfeldt-Jakob syndrome, Paresis, Stroke

INTRODUCTION

Creutzfeldt-Jakob disease (CJD) is a fatal neurodegenerative human prion disease. Based on its cause, CJD can be classified as sporadic, iatrogenic, familial, or variable. Most CJD cases (85%) are sporadic, while 10%–15% of cases are familial, and a minority are iatrogenic. The onset of sporadic CJD (sCJD) usually occurs in the seventh decade of life, with a median time to death of 5 months and with 80% of patients dying within 1 year.[1,2] sCJD is currently incurable. However, an accurate diagnosis in the early stage is crucial to predict the patient's prognosis and rule out the diagnosis of other treatable diseases. Here, we report a patient who was misdiagnosed with recurrent stroke based on brain diffusion-weighted magnetic resonance imaging (DWI) findings, which corresponded to hemiplegia, and who had an unusual clinical course that showed stepwise deterioration.

CASE REPORT

A 70-year-old woman with right hemiplegia visited the hospital on the day of onset. She had not experienced any neurological abnormalities before this presentation and had no medical or family history of brain disease. She was a non-smoker, her blood sugar level was normal, and her serum lipid levels were high (total cholesterol, 273 mg/dL; low-density lipoprotein, 184 mg/dL). She was alert, and her cognitive status was good. Her Korean version of the Mini-Mental State Examination score was high (K-MMSE = 27), with only three points less than a full score in the attention and calculation category. Her right upper and lower extremity muscle strength measured using the Medical Research Council (MRC) scale was 4/4. No abnormalities were identified on laboratory studies, including those of complete blood count, serum electrolytes, liver function, and renal function on the day of admission. Brain DWI showed hyperintense signals in the left frontal and temporal lobe areas (Fig. 1A). Based on hemiplegic symptoms and

corresponding brain imaging results, the patient was diagnosed with cerebral infarction and treatment with aspirin, clopidogrel, and atorvastatin was initiated. Until the 12th day of hospitalization, the patient's symptoms did not worsen or disappear, although her muscle strength remained weakened.

On the 12th day of hospitalization, the patient's level of consciousness temporarily changed to drowsy and her right upper and lower extremity muscle strength measured using the MRC scale deteriorated by 1/2. Brain DWI revealed additional hyperintense signals in the left frontal and temporal lobes and both basal ganglia areas, which led to a diagnosis of recurrent cerebral infarction and continued treatment for stroke (Fig. 1B).

On the 18th day of hospitalization, the patient developed Broca's aphasia. Her cognition deteriorated, and myoclonus appeared in her right upper and left lower extremities. Her scores for memory recall, calculation, and orientation in K-MMSE dropped, with her overall score also lower than the previous results scores (K-MMSE score = 20). Repeated brain DWI confirmed that the hyperintense signals extended to both the cortex and caudate nucleus and putamen (Fig. 1C). In addition to rapidly progressive cognitive impairment, myoclonus, and pyramidal symptoms, she had hyperintense signals in both the caudate nucleus and putamen on brain DWI. Therefore, she was strongly suspected of having CJD and was transferred to another university hospital for accurate diagnostic assessment.

Western blot analysis detected 14-3-3 proteins in her cerebrospinal fluid; real-time quaking-induced conversion assays also detected the scrapie isoform of the prion protein in the cerebrospinal fluid. The possibility of familial CJD was ruled out as no genetic mutations associated with CJD were found in the prion genetic test and she had no family history of CJD. The possibility of iatrogenic CJD was also excluded because she had no medical history of neurosurgical treatment, surgery, or other body tissue transplant at risk of transmission of prion proteins. Thus, the patient was diagnosed with sCJD. The informed consent was waived.

DISCUSSION

The most common early symptom of sCJD is cognitive impairment, and other symptoms such as cerebellar, constitutional, behavioral, sensory, motor, and visual symptoms may also appear.[3,4] The symptoms of sCJD can vary and appear in unusual patterns; thus, this condition may be easily mistaken for other central nervous system disorders.[5] Therefore, the best approach in suspected cases of sCJD is to consider patient care with a critical appraisal of the information known about the disease. The diagnostic criteria for sCJD are outlined in Table 1.[6]

While the clinical features of sCJD can be diverse, acute onset and stepwise deterioration of the pyramidal symptoms resembling the clinical course of a recurrent stroke are rare. However, cerebrovascular diseases usually worsen in a stepwise pattern; thus, it is rare to see a gradual deterioration of symptoms over several hours or days.[7] A previous study reported a case in Korea in which hemiplegia occurred as an initial symptom, with corresponding brain magnetic resonance imaging (MRI) results, after which the patient was diagnosed with sCJD. The case exhibited progressive deterioration of symptoms; the typical symptoms of sCJD such as rigidity, bradykinesia, and tremor appeared 8 days later, which enabled the early suspicion of sCJD.[7] Another case was reported in which atypical white matter lesions were observed on brain MRI, but the

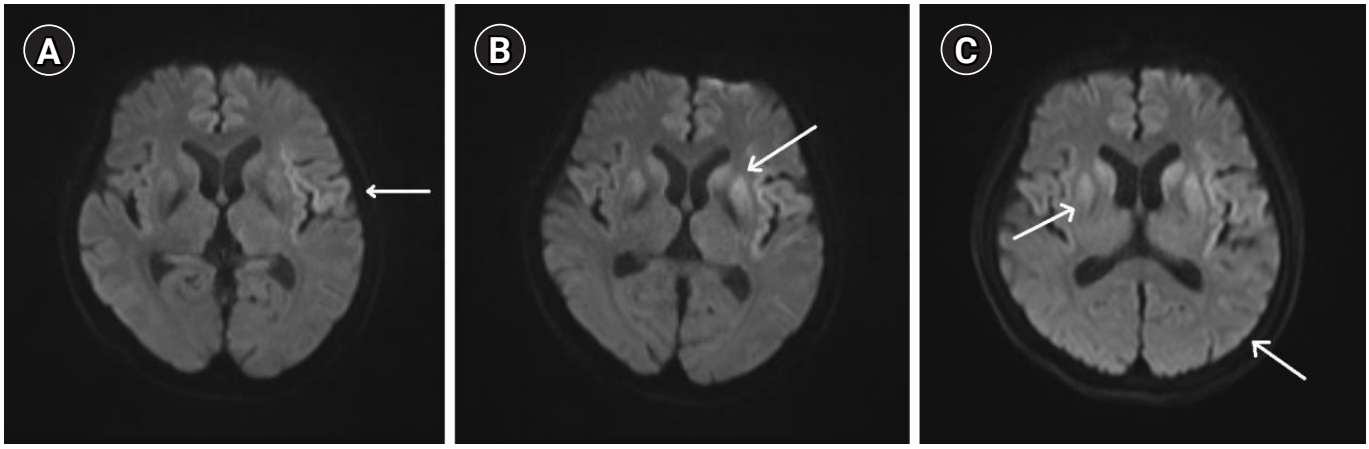

Fig. 1. Axial brain diffusion-weighted images. (A) Initial axial brain diffusion-weighted magnetic resonance imaging (DWI) showing high-intensity signals (arrow) in the left frontal and temporal lobes (0 days from symptom onset). (B) Axial brain DWI showing additional high-intensity signals (arrow) in the left frontal and temporal lobes and the caudate nucleus and putamen (12 days from symptom onset). (C) Axial brain DWI showing extension of the high-intensity signals (arrows) to both the cortex and caudate nucleus and the putamen (18 days from symptom onset).

Table 1. Diagnostic criteria for sCJD

Type	Criteria
A	Rapidly progressive dementia
B	Myoclonus
	Visual or cerebellar signs
	Pyramidal/extrapyramidal signs
	Akinetic mutism
C	Periodic sharp and wave complex on EEG during an illness of any duration
	Positive 14-3-3 cerebrospinal fluid assay and a clinical duration to death of < 2 years
	MRI high-intensity signal abnormalities in the caudate nucleus and/or putamen on diffusion-weighted or FLAIR imaging
D	Routine investigations that do not indicate an alternative diagnosis
E	Duration < 2 years

sCJD, sporadic Creutzfeldt-Jakob disease; EEG, electroencephalography; MRI, magnetic resonance imaging; FLAIR, fluid-attenuated inversion recovery.
Possible CJD = "A" + at least two of "B" + absent "C" + "E."
Probable CJD = "A" + at least two of "B" + at least one of "C" + "D."
Definite CJD = diagnosed using standard neuropathological techniques and/or immunocytochemical analyses; and/or western blot confirmed protease-resistant prion protein and/or the presence of scrapie-associated fibrils.

initial symptoms were typical of sCJD.[8] Another case in Germany described a patient with hemiplegia and corresponding brain MRI findings. This case showed symptoms of cognitive decline before hemiplegia onset, followed by rapid cognitive deterioration. The patient further showed deterioration of symptoms such as dystonic-hyperkinetic movement and myoclonus, which are symptoms of sCJD.[9] Such cases attained a relatively early diagnosis of sCJD as the symptoms had a gradual progressive onset and did not resemble the clinical course of a recurrent stroke.

The patient in the present report had cerebrovascular risk factors such as hypercholesterolemia, old age, and menopause. She also presented with hemiplegia and corresponding high-intensity signals on brain MRI; moreover, her symptoms had acute onset and deteriorated in a stepwise pattern. Furthermore, the changes identified on brain MRI corresponded to those for stroke, leading to a diagnosis of recurrent stroke. Consequently, antiplatelet therapy continued until the typical symptoms of sCJD appeared. The clinical course and imaging results of this case, which resembled those of recurrent stroke, demonstrated the variability of sCJD symptoms. Therefore, it is crucial to understand the potential for uncommon clinical outcomes of sCJD to avoid unnecessary testing and treatment.

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Machine Learning for Geriatric Clinical Care: Opportunities and Challenges

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To the Editor,

Increasing life expectancy and geriatric-related changes pose major challenges for healthcare.[1] Geriatric patients experience many disorders including chronic diseases, weakness, cognitive decline, and functional dependence in the last two decades of life. As these problems can lead to hospitalization, these patients require quality clinical care.[2] Therefore, effective strategies for improving geriatric clinical care are essential.[1]

One strategy to improve patient and clinical team outcomes, reduce costs, and enhance the health of patients is the use of artificial intelligence (AI).[3] AI can play key roles in the prevention, diagnosis, and treatment of patients' problems and the provision of healthcare.[4] AI has been used to detect cancer, disease management using robot-related technologies, provide screening tools to identify the risks of falls and urinary tract infections in geriatric patients with dementia, and assist healthcare providers in clinical decision-making and patient monitoring.[5] AI fills the gap of human resources in geriatric clinical care, reducing the burden on their family caregivers and, ultimately, improving the quality of care and life of older adults.[6] Machine learning (ML) is one of the main components of AI that uses statistical techniques to allow computer programs to make decisions and predictions based on previous data and experiences.[6] Recently, special attention has been paid to ML in the medical literature. Thus far, ML has been used to identify older people at high risk for dementia; predict weakness, risk of falls, pneumonia, delirium, and acute kidney injury; and provide geriatric clinical care to prevent these problems.[7] Moreover, these well-developed models show accuracy surpassing that of humans.[8]

Many opportunities exist for the implementation of ML to improve geriatric care in the clinical setting. These opportunities include clinical task automation, optimizing clinical decision-making and support in practice, expanding clinical capacity, improving the safety level of geriatric patients, and increasing the quality of their care;[9] telemedicine and robot-related technologies for social communication and rehabilitation of geriatric patients with physical disabilities, Parkinson disease, and chronic hemiparetic gait as well as for post-stroke patients; virtual reality environments to improve anxiety, depression, loneliness, social isolation, gait, posture, and pain;[7] and interpretation of motion parameters and assessment of body composition or physical performance from vision datasets or opportunistic imaging datasets.[9,10] Therefore, health managers and policymakers should pay special attention to ML to improve geriatric clinical care.[11]

However, the implementation of ML for geriatric clinical care has challenges including causality, missingness, and outcome definition. Data collection is often performed in a clinical setting via observation. The application of observational data to answer causal questions in a clinical setting is challenging. However, observational data may provide information that is often ignored. Therefore, learning models that do not consider missingness indicators can lead to inaccurate assessments and reflections of human biases. In contrast, reliable learning outcomes play an important role in assigning tasks. The key factors in outcome definitions in clinical settings are reliable outcomes, perception of clinical relevance, and the subtlety of label leakage, which can be effective in the implementation of ML for geriatric clinical care.[11] Some additional challenges of using ML for geriatric clinical care include ethical concerns such as racial biases,[12] privacy, equity, security, disruption of human communication and data management, and cost of care.[7] One of the major challenges in the implementation of ML for geriatric clinical care is the problem of annotation of real-life emotions. Data related to the expression of emotions are rare and cannot provide a basis for annotation and modeling using fine-grained emotion labels. However, inter-labeler agreement and annotation label confidence are important factors that need to be addressed to solve this challenge.[13] Therefore, these challenges remain a major con-

cern for the implementation of ML in geriatric clinical care.[7]

Overall, the implementation of ML to improve geriatric clinical care is a questionable hypothesis requiring additional evidence. Thus, further research is needed to address the challenges of using ML for geriatric clinical care.

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Any appeal against an editorial decision must be made within 2 weeks of the date of the decision letter. Authors who wish to appeal a decision should contact the Editor-in-Chief, explaining in detail the reasons for the appeal. All appeals will be discussed with at least one other associate editor. If consensus cannot be reached thereby, an appeal will be discussed at a full editorial meeting. The process of handling complaints and appeals follows the guidelines of COPE available from https://publicationethics.org/appeals. AGMR does not consider second appeals.

MANUSCRIPT PREPARATION

AGMR focuses on clinical and experimental studies, reviews, case reports, editorials and letters in geriatric medicine and gerontology. Any researcher throughout the world can submit a manuscript if the scope of the manuscript is appropriate.

General Requirements

- The manuscript must be written using Microsoft Word and saved as ".doc" or ".docx" file format. The font size must be 11 points. The body text must be left aligned, double spaced, and presented in one column. The left, right, and bottom margins must be 3 cm, but the top margin must be 3.5 cm.
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- A complete title page should be submitted separately from the main document file, and the latter should contain no information that identifies the author or the author's institutional affiliation.
- All manuscripts must be written in clearly understandable English. Authors whose first language is not English are requested to have their manuscripts checked for grammatical and linguistic correctness before submission. Correct medical terminology should be used, and jargon should be avoided.
- The use of abbreviations should be minimized and restricted to those that are generally recognized. When using an abbreviated word, it should be spelled out in full on first usage in the manuscript, followed by the abbreviation in parentheses.
- Numbers should be written in Arabic numerals, but must be spelled out when placed at the beginning of a sentence.
- Drugs and chemicals should be referred to using standard chemical or generic terms. The names and locations (city, state, and country only) of manufacturers of equipment and non-generic drugs should be given.
- Measurements should be described using the metric system, and hematologic and biochemical markers using the International System of Units. All units must be preceded by one space, except for the following symbols: percentage (%), temperature (°C), and degree (°).

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Composition of Manuscripts

The manuscript sections should be presented in the following order: Cover Letter, Title Page, Abstract and Keywords, Introduction, Materials and Methods, Results, Discussion, Acknowledgements, References, Tables, and Figure Legends. Provide only one table or figure per page. Table 1 shows the recommended maximums of manuscripts according to publication type; however, these requirements are negotiable with the editor.

Table 1. Recommended maximums for articles submitted to AGMR

Type of article	Abstract (word)	Text (word)[a]	Reference	Table & figure
Original article	Structured[b], 250	3,500	50	7
Review	150	6,000	unlimited	7
Case report	150	1,500	20	7
Editorial	No	1,200	15	7
Letter to the editor	No	1,200	15	1

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[a]Maximum number of words is exclusive of the abstract, references, tables, and figure legends.
[b]Background, methods, results, and conclusion.

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Guidelines for the Main Body

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Reference Style

- Journal article:

1. Oh TJ, Song Y, Moon JH, Choi SH, Jang HC. Diabetic peripheral neuropathy as a risk factor for sarcopenia. Ann Geriatr Med Res 2019;23:170-5.

- Book:

2. Fillit H, Rockwood K, Woodhouse K, Young JB. Brocklehurst's textbook of geriatric medicine and gerontology. 8th ed. Philadelphia, PA: Elsevier; 2016.
3. Korea National Statistical Office. Annual report on the cause of death statistics, 2015. Daejeon: Korea National Statistical Office; 2016.

- Book chapter:

4. Phillips SJ, Whisnant JP. Hypertension and stroke. In: Laragh

JH, Brenner BM, editors. Hypertension pathophysiology, diagnosis, and management. 2nd ed. New York, NY: Raven Press; 1995. p. 465-78.

- Website:

5. AMA: helping doctors help patients [Internet]. Chicago, IL: American Medical Association; c2019 [cited 2019 Dec 22]. Available from: http://www.ama-assn.org.

Tables and Figures

Tables should be submitted separately from the main body of the paper, and figure legends should be typed on separate sheets.

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General guidelines are same as for original articles.

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